THE BULLETIN

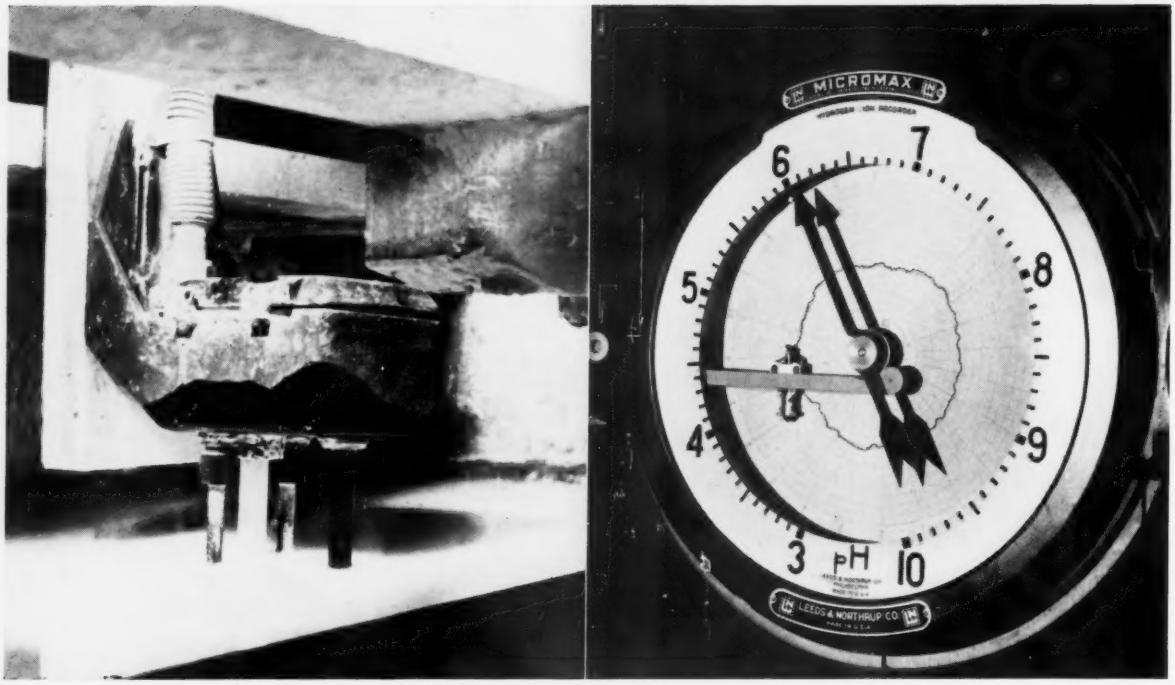
OF THE

AMERICAN CERAMIC SOCIETY

Volume 20 SEPTEMBER, 1941 Number 9

WILLIAM LLOYD EVANS

For story, see page 315



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THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

Volume 20 **Contents for September, 1941** **Number 9**

PAPERS

Notes on Pyrometric Cone Equivalent Determinations—E. C. Petrie 299–302

Practical Aspects of Particle-Size Control—S. C. Lyons 303–306

Influence of Firing and Cooling Rates on Properties of a Vitreous China Body—A. E. Currier and A. S. Watts 307–309

Practical Application of Automatic Heat and Humidity Controls to Driers—R. R. Robinson 309–11

Use of Phosphate Opacifying Agents in Sanitary-Ware Glazes—W. H. Earhart 312–13

Notes on Casting—G. W. Phelps 313–15

Advertisers' Index **6**

Buyers' Guide **12, 16, 18, 20**

INDEX TO CERAMIC HISTORY, ACTIVITIES, NOTES

Art Division. See *Divisions.*
Autumn Meetings. See *Meetings, autumn.*

Bahnsen, M. J., appointed assistant director of Ferro Laboratories, p. 317.
Brown, H. S., necrology, p. 322.
Burton, William, necrology, biog., pp. 323–24.

Ceramicenter, established for ceramic artists, p. 320.
Ceramic history, Evans, W. L., biog., pp. 315–16; photo, September cover.
Ceramic schools, New York State College of Ceramics, staff appointments, p. 318.
University of North Carolina, changes in faculty, p. 318.
Clay products research program, outline, p. 317.

Divisions, Art, autumn meeting, Blue Ridge N. C., résumé, photos, pp. 321–22.
Materials and Equipment, joint autumn meeting with White Wares Division, program, p. 316.
Refractories, autumn meeting, program, p. 325.
White Wares, joint autumn meeting with Materials and Equipment Division, program, p. 316.

Eastern Enamelers' Club fall meeting, program, p. 318.
Evans, W. L., biog., pp. 315–16; photo, September cover.

Exhibitions, New York Society of Ceramic Arts, (41st Annual), announcement, p. 320.

Industrial research laboratories, directory published, p. 320.
Industrial safety report, issued by Metropolitan Life Insurance Co., p. 320.
Institute of Ceramic Engineers, letter from Washington, p. 316.
new members, p. 316.

Krehbiel, J. F., necrology, biog., photo, p. 323.

Laboratories, industrial research, directory published by National Research Council, p. 320.
Leach, W. R., necrology, biog., photo, p. 322.

Materials and Equipment Division. See *Divisions.*
McPherson, William, story of W. L. Evans, pp. 315–16.
Meetings, autumn, Art, Blue Ridge, N. C., résumé, photos, pp. 321–22.
Materials and Equipment and White Wares Divisions, program, p. 316.
Refractories, program, p. 325.
White Wares and Materials and Equipment Divisions, program, p. 316.
Members, membership workers' record, p. 319.
new, for August, p. 319.
paid membership record, opposite p. 314.
roster changes during August, p. 319.
Minerals, nonmetallic, advisory group of technologists to aid defense, personnel, p. 320.

National Research Council, industrial research directory published, p. 320.
research report, findings and recommendations, pp. 324–25.
Necrology, Brown, H. S., p. 322.
Burton, William, biog., pp. 323–24.
Krehbiel, J. F., biog., photo, p. 323.
Leach, W. R., biog., photo, p. 322.
New York Society of Ceramic Arts, 41st Annual Exhibition, announcement, p. 320.

Pacific Northwest Clayworkers' Association, annual summer meeting, p. 318.
Photographs, ceramic ware at Art Division meeting, Blue Ridge, N. C., pp. 321–22.
Evans, W. L., September cover.
Krehbiel, J. F., p. 323.
Leach, W. R., p. 322.

Refractories Division. See *Divisions.*
Research, industrial, directory of research laboratories published by National Research Council, p. 320.
National Research Council report, findings and recommendations, pp. 324–25.
Structural Clay Products Institute program, outline, p. 317.

Safety, industrial, Metropolitan Life Insurance Co. report issued, p. 320.
Structural Clay Products Institute, outline of research program, p. 317.

Talbott, P. T., at Battelle Memorial Institute, p. 318.
Technologists, nonmetallic minerals, advisory group to aid defense, personnel, p. 320.

White Wares Division. See *Divisions.*

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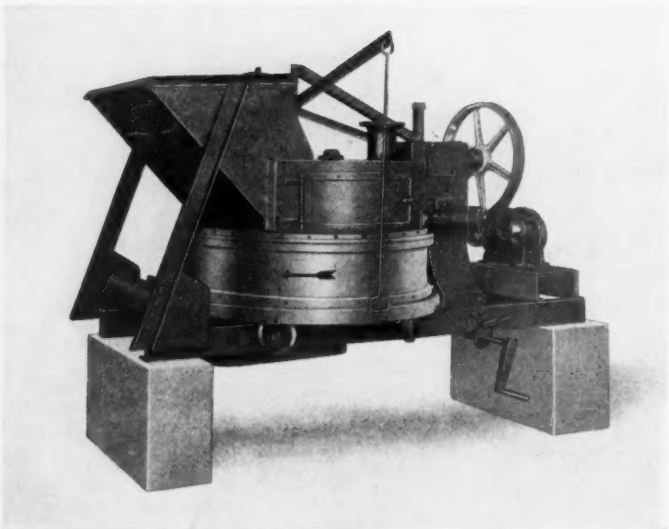

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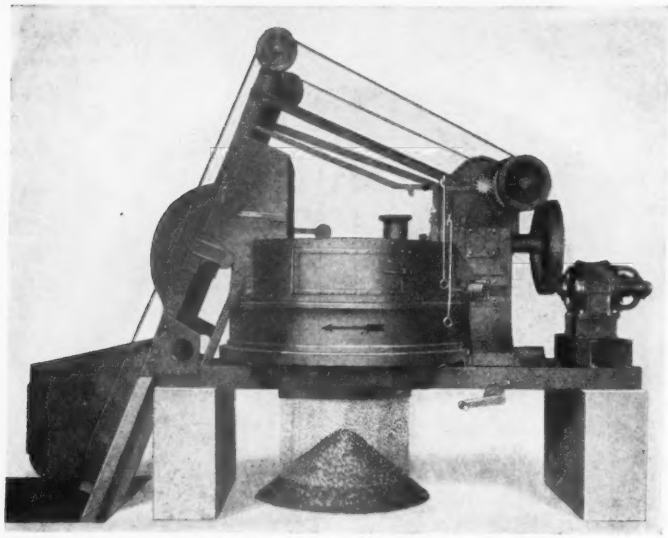

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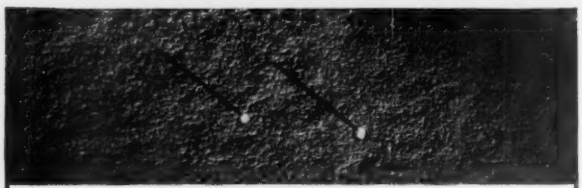

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ALPHABETICAL LIST OF ADVERTISERS

	Page
American Colloid Co.	17
American Potash & Chemical Corporation	8
American Telephone & Telegraph Co.	24
Bausch & Lomb Optical Co.	7
Buyers' Guide	12, 16, 18, 20
Ceramic Color & Chemical Mfg. Co.	4
Classified Advertisements	19
Corhart Refractories Company	10
Denver Fire Clay Co.	4
Du Pont de Nemours, E. I., & Co., Inc.	13
Foote Mineral Co.	21
Frazier-Simplex, Inc.	11
Hammill & Gillespie, Inc.	23
Harshaw Chemical Co.	5
Hickory Clay Products Co.	19
Hommel, O., Company	23
Industrial Ceramic Products, Inc.	21
Ingram-Richardson Mfg. Co. of Indiana, Inc.	23
International Pulp Co.	19
Kentucky Clay Mining Co.	7
Lancaster Iron Works, Inc.	2–3
Leeds & Northrup Co.	Inside Front Cover
Louthan Mfg. Co.	23
Maxson, Elwyn L.	15
McDanel Refractory Porcelain Company	8
Metakloth Co.	8
Metal & Thermit Corporation	Outside Back Cover
Montgomery Porcelain Products Co.	6
National Engineering Co.	9
Norton Co.	*Center Spread
Pacific Coast Borax Company	14
Paper Makers Importing Company, Inc.	15
Porcelain Enamel & Mfg. Company	8
Potters Supply Company	14
Proctor & Schwartz, Inc.	8
Professional Directory	19
Society of Glass Tech.	17
Solvay Sales Corporation	4
Spinks, H. C., Clay Company	Inside Back Cover
Swindell-Dressler Corp.	21
Thomas Alabama Kaolin Co.	23
United Clay Mines Corp.	8
Vitro Mfg. Company	6
Wilson, H. W., Company	14

* Pages marked E appear in Editorial Section.

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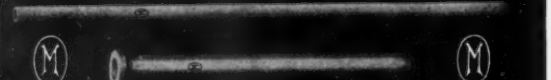

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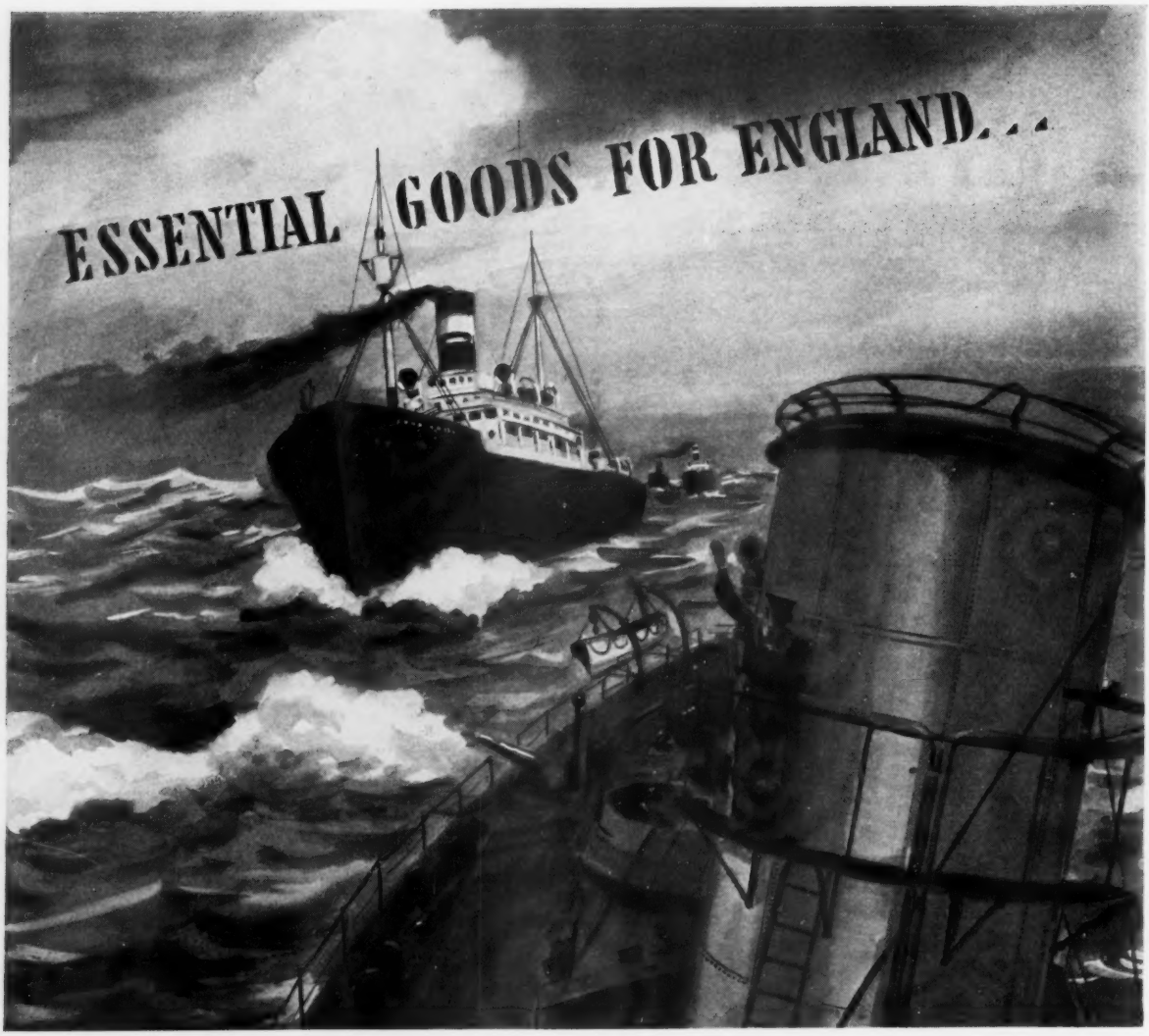

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A Monthly Publication Devoted to Proceedings of The Society and Promotion of Cooperative Research of Technical, Scientific, and Art Questions

Volume 20 **SEPTEMBER, 1941** **Number 9**

PAPERS

NOTES ON PYROMETRIC CONE EQUIVALENT DETERMINATIONS*

By Earl C. Petrie†

Abstract

This work relates to the technique involved in determining the P.C.E. of refractory materials. It has been found necessary to check particularly the material used in making the cone plaque in determining the P.C.E. of high-alumina samples. Certain materials usually considered to be sufficiently refractory for this purpose can be a cause of low P.C.E. values. A common practice is to use organic binders in forming test cones. These binders may cause some clays to bloat during the heat-up period, and such bloating prevents accurate determination of the end point.

I. Introduction

The determination of the pyrometric cone equivalent of refractory materials is subject to a number of variables which occasionally may prevent the exact duplication of results, especially when the tests are conducted in different laboratories with different equipment. Two sources of error may result, namely, (1) the reaction between the test cones and the material used for the plaque and (2) the bloating of unfired clays which may affect the usual bending of the cones before the end point is reached.

II. Cone Plaque Reactions

Some of the more common materials which are used to make cone plaques are Alundum cements and mixtures of refractory fire-clay grog and plastic clay. These materials have been considered satisfactory for tests on raw or fired products that range in silica-to-alumina ratio from silica brick to high-alumina refractories. Such incompatible materials apparently do not give true end points because of the reaction that occurs between the test cones and the plaque material.

A certain grade of Alundum cement has been in use for some time for cone plaques because of its convenience and satisfactory behavior. This same type of cement was purchased from another manufacturer, however, and, although it appeared equally refractory, it interfered with the accuracy of the P.C.E. determination. A careful observation of tests on highly refractory diaspores revealed a change in color at the base of the test cones and in the plaque material surrounding the cones. Comparative tests of different plaque materials showed that the P.C.E. value on one sample might vary from cones 34–35 to 37.

The results of this work (Fig. 1) show two cone plaques of different types of material used in a P.C.E. test of refractory diaspore. The plaque on the left was comprised of more than 90% of alumina; the other plaque was made of the unsatisfactory commercial product, designated as cement No. II. The darker colored test cones of each plaque were molded from the same sample of diaspore clay. The plaque on the left was

Fig. 1.—Effect of two types of cone plaque material on the P.C.E. of a diaspore sample; *left*, plaque heated to cone 36; *right*, plaque heated to less than cone 35; note behavior of test cones.

* Presented at the Forty-Second Annual Meeting, The American Ceramic Society, Toronto, Canada, April 10, 1940 (Refractories Division). Received May 16, 1941.

† Fellow, Refractories Fellowship, Mellon Institute, Pittsburgh, Pa.

heated until cone 36 bent well over (right-hand side of plaque) although the test cones were unchanged. The other plaque (right side) was heated until standard cone 35 had just started (at the back of the plaque), although all of the six diaspore cones were "flat."

The composition of the commercial cement No. II was found to be the cause of this pronounced difference in the behavior of the test cones. The constituents of the cement were essentially fused alumina and a plastic portion that had P.C.E. values of 9 to 10. Further analysis showed that it contained approximately 1% of soluble fluxing constituents comprised of lime, magnesia, and alkalis.

To determine the change in composition which apparently had occurred in the test cones, a chemical analysis was made of the cones in each plaque of Fig. 1. A similar P.C.E. test was made, using a satisfactory commercial material for the plaque designated as cement No. I, and the diaspore test cones from this run, together with an original sample, were analyzed. Table I presents the information obtained from these analyses; with the composition of the unused diaspore as a basis, the changes in composition of the three plaque materials are shown. The P.C.E. value of each plaque material is also given. The use of such materials as cement No. II apparently is responsible for a marked change in the composition of the sample, which, of course, affects the P.C.E. value.

TABLE I

EFFECT OF CONE PLAQUE MATERIALS IN CHANGING THE COMPOSITION OF A DIASPORE WHILE BEING TESTED FOR P.C.E.

	Test cone original composition (%)	Change in composition of test cones caused by P.C.E. determinations made with different plaque materials (%)		
		Clay-bonded alumina	Cement No. I	Cement No. II
Silica	6.43	+0.65	+2.58	+9.24
Alumina	88.08	+0.01	−3.46	−12.10
Iron oxide	0.62	+0.07	+0.38	+0.09
Titania	3.56	+0.03	+1.15	+1.56
Lime	0.14	+0.05	+0.13	+0.84
Magnesia	0.16	+0.01	+0.03	+0.32
Alkalis	1.01	−0.82	−0.81	+0.05
Total	100.00			
P.C.E.		37+	37	34–35

In view of this comparison, P.C.E. tests were conducted on a variety of silica-alumina refractory materials to determine the effect of cement No. II as a plaque material. These samples were also tested, for comparison, using cone plaques made of the 90% alumina mix (see Table II). Except for the two high-alumina samples, Nos. 9 and 10, cement No. II did not cause more than one-half cone difference in the results (samples Nos. 3 and 5).

A satisfactory cone plaque material with good working properties is a mixture of fused alumina (60-mesh and finer) and a plastic clay which has a P.C.E. of 32 or higher. Not more than 25% of the plastic clay should be necessary.

Although the foregoing information refers to cone-plaque reactions in which low-melting constituents in the plaque react with the test cones, it is also conceivable that the reverse might take place, that is, the seeping away of low-temperature glasses from test cones and absorption by the plaque. This action could increase the refractoriness of the test cones, and further tests on certain types of refractories may show that the plaque material supporting the test cone should be of the same material as the cone itself. Such practice is currently followed to a certain extent by using plaque segments of the same general composition as the test sample.

TABLE II

EFFECT OF CONE PLAQUE MATERIAL ON P.C.E. DETERMINATION OF A VARIETY OF REFRACTORY MATERIALS

	Sample No.	Kind of plaque material	
		Clay-bonded alumina	Cement No. II
1	Cold-set refractory mortar	16	16
2	Siliceous clay brick	29–30	29–30
3	Clay brick	29	29–30
4	Plastic fire clay	31–32	31–32
5	Silica brick	31	31–32
6	Fire-clay brick	31–32	31–32
7	Fire-clay brick	33–34	33–34
8	Superduty fire-clay brick	34–35	34–35
9	Diaspore clay "A"	Above 37	34–35
10	High-alumina brick	Above 37	34–35

III. Bloating of Cones During Heating

The second source of inaccuracies pertains to the bloating of test cones during the heating period. Because bloating prevents the normal bending behavior of cones, it may cause either higher or lower P.C.E. end points. A comparatively small percentage of typical test samples exhibits this property, and it occurs principally with plastic clays; it is also more prevalent in clays of low refractoriness, but occasionally those running as high as cones 31 to 32 bloat to a degree which prevents a satisfactory determination.

A study of this property was prompted because of the unusual behavior of a certain refractory plastic clay which bloated excessively. It was discovered, however, that bloating was caused by a starch paste used in making the cone; when the sample was made

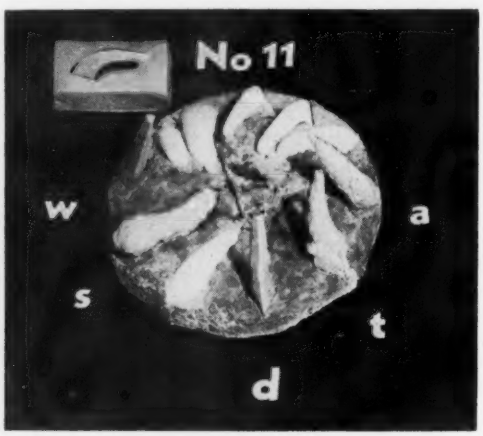

FIG. 2.—Clay (cones 31 to 32) heated to show effect of using water, starch, dextrin, gum tragacanth, and gum arabic as binders to form test cones.

up with water only, it behaved more or less normally. It was decided, therefore, to study the effect of various organic binders on this sample. Test cones were made using the required amounts as follows: starch paste 10%, dextrin solution 75%, tragacanth paste 6%, and gum arabic solution 75%; these test cones were compared with cones made up only with water.

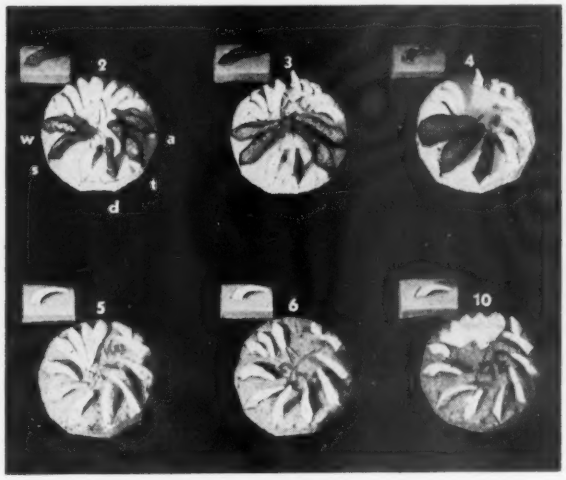

FIG. 3.—Cone plaques showing behavior of six types of clays with various binders used to form test cones.

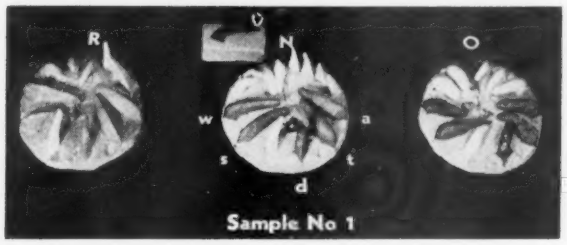

FIG. 4.—Clay No. 1 made up with the various binders and also after runs in which the furnace gas atmosphere was maintained as reducing (*R*), neutral (*N*), and oxidizing (*O*).

The cone plaque of Fig. 2 shows the behavior of the experimental cones made from this clay (No. 11). The different binders used are indicated opposite the cones by the letters *w*, *s*, *d*, *t*, and *a*. The *s*, *t*, and *a* cones bloated badly, whereas those made with water and dextrin did not exhibit this property. This clay shows an end point of cones 31 to 32 when it is made up with water, but it gives an apparent P.C.E. of 30 to 31 when a gum arabic solution is used. No bloating occurs when the clay is calcined to approximately 1000°C. for 1 hour to remove organic matter and is then made up with dextrin. A sample cone prepared in this way is shown in the small rectangular pat in Fig. 2 (upper left).

A similar series of tests was conducted on other plastic clays, and a group of these is shown in Fig. 3. The numbers above the plaques identify the clay samples; in sample No. 2, the legend gives the position of the test cones made up with water and the four binders. The same arrangement was used for the respective positions of the experimental cones in the other plaques.

Bloating which takes place in varying degrees in different clays may be the result of the type of binder that is used in forming the cone. The cones, moreover, made from the calcined clay (shown in the rectangular plaques) have little or no tendency to bloat.

Figure 4 presents plaques for sample No. 1; the letters, *R*, *N*, and *O* above the plaques signify, respectively, the reducing, neutral, and oxidizing atmospheres which were maintained during the tests. No CO_2 was present during the reducing run, *R;* in the oxidizing atmosphere, *O*, the excess air reduced the CO_2 to between 5 and 9%. The degree of bloating apparently is not greatly affected by the atmosphere

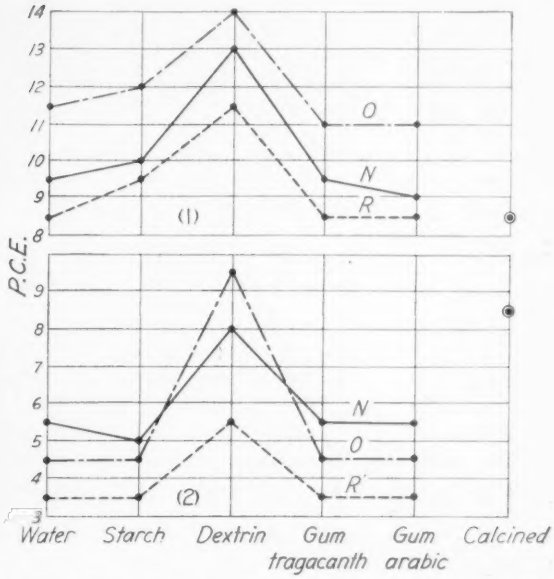

FIG. 5.—(1) Sample No. 2, Illinois, and (2) sample No. 1, Ohio.

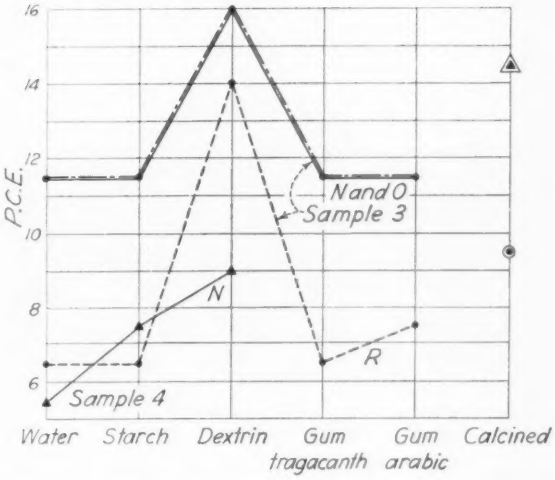

FIG. 6.—Sample No. 4, Ohio, and sample No. 3, Illinois.

although there is a tendency toward increased bloating with the reducing atmosphere.

This series of gas-atmosphere determinations was made on eleven types of samples which bloat; the apparent P.C.E. values determined in these tests are given in Figs. 5, 6, 7, and 8. These data show that differences in P.C.E. results are caused by the binder used and by the atmosphere. Such effects are more pronounced in clays which have a low P.C.E. The charts also give the cone end points when the samples have been calcined as a powder and later bonded with dextrin.

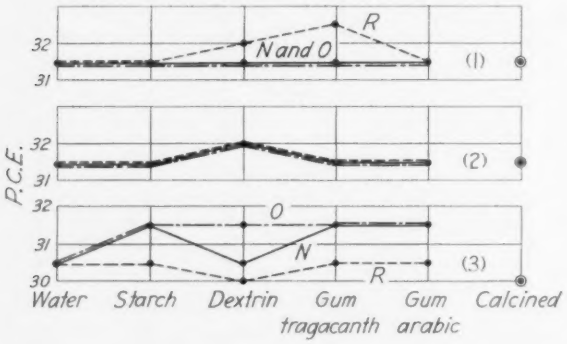

FIG. 7.—(1) Sample No. 10, Pennsylvania; (2) sample No. 9, Missouri; and (3) sample No. 8, Ohio.

Because calcining the clays is a virtual remedy for bloating, the question arises as to the best method to use. Samples Nos. 1, 2, and 6 were heated to 1000°C. for a 30-minute period, both as a 65-mesh powder and in the form of cones molded with water. The material for these tests was placed in a cold furnace and heated; other tests were carried out in which the samples were placed in a preheated electric furnace. Sample No. 2, moreover, was treated by each method for periods of 1, $1^1/_2$, and 2 hours.

These tests showed the advantage of using powdered material in calcination and the beneficial effect of bringing the samples to temperature as the furnace was heated. An increase in the time period beyond $^1/_2$ hour did not affect the small residual bloating that occurred in sample No. 2.

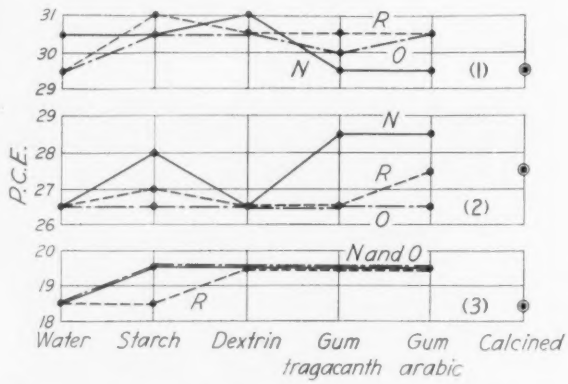

FIG. 8.—(1) Sample No. 7, Ohio; (2) sample No. 6, German; and (3) sample No. 5, Illinois.

IV. Summary

(1) The type of material used for cone plaques should be selected carefully in order to prevent the migration of the lower melting constituents from the test cones to the plaque or vice versa.

(2) The use of organic binders in making up test cones of unfired clays may cause or increase bloating during the test.

(3) A reducing atmosphere during the test tends to accentuate bloating.

(4) As a precautionary measure, all unfired clays should be calcined before the test cones are made. It is suggested that the sample be ground to pass a 65-mesh Tyler standard sieve and heated at 950° to 1000°C. in an electric furnace for $^1/_2$ hour. The test cones may then be made with the use of an organic binder such as starch paste.

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PRACTICAL ASPECTS OF PARTICLE-SIZE CONTROL*

By S. C. Lyons

Abstract

The nature of fractionation is described, and photomicrographic and analytical data are given on some clay fractions. The present technical and industrial applications of fractionated products are discussed, and the basic principles of pneumatic and hydraulic classification are reviewed together with certain practical considerations. The advantage of hydraulic separations made under high settling forces, that is, centrifugal forces, are outlined and the processes and machines are presented.

I. Introduction

Clay particles, by virtue of their enormous surface area per unit of mass, can adsorb on their faces comparatively minute amounts of various ions. The adsorbed ions, in turn, may have a profound effect on the structural relations of the particles toward each other. This effect, moreover, is not limited to the behavior of the clays in their wet and dry condition; it extends also into the firing behavior because the relative orientations impressed on the particles during the forming and drying processes affect their actions during firing.

Different particle-size fractions of a clay usually show marked differences in working and firing properties,[1] that is, in drying and firing shrinkage, water of plasticity, and in drainage in casting, dry modulus, and porosity. The firing range is affected by particle size.[2] Clays used in paper coating, moreover, must have a particle-size distribution ranging from 2 to 0.5 μ if the maximum of hiding power and gloss are to be obtained from the coating film.[3]

II. Improved Fractions by New Methods

Improved fractionations are now obtained by new centrifugal methods, which result in increased sharpness. These methods also have the advantage of easy control and reproducibility.

In addition to particle-size separations, interesting mineralogical and chemical segregations may be determined. A primary kaolin, for example, was broken down by centrifugal action into three fractions of different particle size. When it was analyzed, a progressive variation of chemical composition with particle size was determined (see Table I).

This table shows the progressive increase in alumina with increased particle fineness, and the corresponding decrease in silica, which denotes increasing amounts of quartz impurities in the coarser fractions. The alkali content likewise decreases with particle fineness, owing to the fine sericite mica in the coarser particle ranges.

III. Review of Classification Methods

(1) Different Known Methods of Fractionation

There are not many basically different methods for subsieve particle-size control at the present time. All of the methods rely on the principle of "Stokes' law," and an enormous amount of experimental and theoretical effort has been devoted to this subject.[4] This principle postulates that if two spherical particles, 1 and 2 μ in diameter, respectively, be allowed to subside in a quiescent liquid, they will settle out at rates proportional to the square of their respective diameters, that is, the 2-μ particle will subside about four times

Table I

	Coarse (%)	Intermediate (%)	Fine (%)
H_2O	0.53	0.66	0.58
Ignition loss	6.54	8.86	12.35
SiO_2	63.92	54.42	47.40
TiO_2	1.33	1.29	1.01
Fe_2O_3	0.98	0.89	0.49*
Al_2O_3	22.79	30.44	36.50
Alkalis	3.60	3.34	1.62
Total	99.69	99.90	99.95

* Iron content of fines reduced slightly by chemical bleaching.

* Presented at the Forty-Third Annual Meeting, The American Ceramic Society, Baltimore, Md., April 1, 1941 (Materials and Equipment and White Wares Divisions). Received February 17, 1941.

[1](a) H. Whitaker, "Effect of Particle Size on Plasticity of Kaolinite," *Jour. Amer. Ceram. Soc.*, **22** [1] 16–23 (1939).

(b) S. C. Lyons, "Notes on Fractionation and Products Resulting Therefrom," *Bull. Amer. Ceram. Soc.*, **18** [9] 321–22 (1939).

[2] R. F. Geller and E. N. Bunting, "Length Changes of Whiteware Clays and Bodies During Initial Heating, with Supplementary Data on Mica," *Jour. Research Nat. Bur. Stand.*, **25** [1] 15–40 (1940); R.P. 1311; *Ceram. Abs.*, **19** [11] 266 (1940).

[3](a) S. C. Lyons, "Effect of Particle Size of Clays Upon Paper Coating Properties," *Paper Trade Jour.*, **106** [26] 102–103 (June 30, 1938).

(b) W. T. Maloney, "Clay Product and Process of Preparing," (Ga. Kaolin Co.). U. S. Pat., 2,158,987, May 16, 1939 (Nov. 26, 1934); *Ceram. Abs.*, **18** [7] 195 (1939).

[4] (a) E. Schramm and E. W. Scripture, Jr., "Particle Analysis of Clays by Sedimentation," *Jour. Amer. Ceram. Soc.*, **8** [4] 243–52 (1925).

(b) Thomas R. Camp, "Study of Rational Design of Settling Tanks," *Sewage Works Jour.*, **8** [5] 742–58 (Sept., 1936).

(c) F. H. Norton and S. Speil, "Measurement of Particle Size in Clays," *Jour. Amer. Ceram. Soc.*, **21** [3] 89–97 (1938).

(d) E. A. Hauser and J. E. Lynn, "Separation and Fractionation of Colloidal Systems," *Ind. Eng. Chem.*, **32** [5] 659–62 (1940); *Ceram. Abs.*, **19** [7] 169 (1940).

(e) E. A. Hauser and H. K. Schackman, "Particle-Size Determination of Colloidal Systems by the Supercentrifuge," *Jour. Phys. Chem.*, **44**, 584–91 (May, 1940); *Ceram. Abs.*, **19** [10] 240 (1940).

(f) A. Casagrande, Hydrometer for Determination of Fineness Distribution of Soils. Julius Springer, Berlin, 1934.

as rapidly as the particle of 1-μ size. Although clay particles are not spherical, they are so small that they have a tendency to behave in suspension as spheres.

(2) Various Forms of Hydraulic Classification

(*A*) *Elutriation:* The elutriation process is of relatively little commercial importance. Some processes, which are assumed to be "elutriation," function almost entirely along the principles of levigation.

A current of water, for example, flows upward at a uniform rate throughout a glass tube, 1 in. in diameter; if a mixture of particles of various sizes were introduced, the finer would be swept upward along with the current, the coarsest would settle downward against the current, and the others would remain suspended (more or less indefinitely) within a relatively narrow range of travel, but they would eventually travel in one or the other direction. This process is effective for particle-size segregation for laboratory purposes and also for relatively coarse particles.

Figure 1 shows that, to satisfy the principle of an elutriator, the direction of flow of the fluid suspension within the elutriating column must be parallel to its vertical axis at all points, but this specification is rigidly fulfilled only when the diameter of the column is very small.

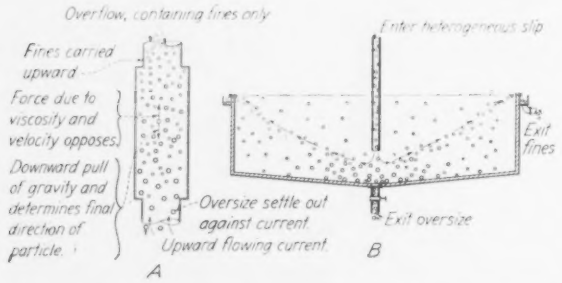

FIG. 1.—Elutriation principle: (*A*) theoretical function; (*B*) practical application (note approach to ordinary levigation).

The subsidence rate of a 2-μ clay particle in water (under gravity) at 30°C. is about 1 in. in 120 minutes. An elutriator which is to reject particles of 2-μ diameter and coarser must therefore maintain an upward flow of not more than 0.5 in. per hr.

An elutriator that will produce 2 tons per hr. of fine-particle clay requires a column large enough to handle several thousand gallons of slip per hour at an upward rate of flow of 0.5 in. per hr.; a circular tank, possibly 20 to 30 ft. in diameter, would thus be necessary. Inasmuch as it is customary in commercial "elutriation" practice to introduce the slip near the center of the tank and collect the overflow around its periphery, the "elutriator" approaches an ordinary levigator or settling tank in its functional principle.

Coarse sand and mica tend to settle out of suspension of a slowly flowing clay slip. As the slip flows along the trough, progressively finer particles will be removed so that when the slip finally overflows a wier at the far end of the settling chamber, it will have lost most of the particles which were coarse enough to subside from their position in the slip stream to the bottom of the trough during the interval required for the slip to flow through the chamber (Fig. 2). This time interval hereafter will be referred to as the "detention period."

If more of the same slip is passed through an identical trough, but, at twice its former speed (i.e., one half of its detention period), some of the coarser particles that settled out in the previous run will have insufficient time under these new conditions to reach the bottom of the trough and will be carried over with the fines. It is thus apparent that the fineness of the product of levigation can be determined largely by its detention period.

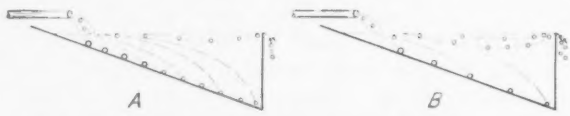

FIG. 2.—Elementary principle of hydraulic classification: (*A*) long detention period, only fines overflow; (*B*) short detention period, intermediate sizes also overflow.

As the levigation proceeds, the effective detention period may become progressively reduced by filling the chamber with accumulated rejects so that coarser products result unless suitable provision is made for their removal to avoid resuspension of previously settled rejects and turbulent flow. This is a matter of basic importance and will be discussed later.

(3) Advantages of Higher Settling Forces

In practical terms, there is an incompatibility between shallow pools and long detention periods. A settling tank must have a greater area laterally as its depth is diminished to afford a given velocity of flow through it while transmitting at any specified volumetric rate. This design, however, results in several practical difficulties. A low uniform rate of flow is difficult to maintain without channeling or "meandering" through a wide shallow pool, and it is not easy to remove accumulated sediment from such units without developing some turbulence.

The most obvious benefit of high settling forces therefore is that they effect a marked reduction in the time of detention so that shallow-pool settling conditions may be used effectively even within compact physical limits.

(*A*) *Resuspension of Sediment:* In any hydraulic classification system, the velocity of flow of the suspension across a given area of tank bottom will increase as the depth is reduced, assuming the lateral geometry of the system to remain constant. As this velocity is increased, the particles which have already settled out tend to be swept along with the current and to be resuspended. High settling forces, therefore, would be advantageous in that they tend directly to suppress resuspension.

(*B*) *Electrokinetic and Mechanical Effects:* As the particle size decreases, the effect of surface influences frequently increases enough to become a controlling

factor. Most clays, as received for processing, tend to flocculate. Although these "flocs" are fragile, they are strong enough to prevent the free subsidence of many clay particles as coarse as 40 μ or more. The flocs could easily be dispersed temporarily by a little mechanical agitation, but such treatment in a settling system operating under gravity settling forces would result in a considerable turbulence, with a consequent resuspension of oversize particles. It becomes necessary therefore to deflocculate the slip by chemical means.

Deflocculation, however, introduces undesirable soluble salts as well as the subsequent necessity of adding more salts (of a different character) to reflocculate the particles so that they may be removed from suspension by filtering.

IV. Centrifugal Fractionation

(1) Methods of Developing High Forces, Centrifugation

Centrifugation is the only practical method that is currently known for developing intensive settling forces. The degree to which such forces could be increased theoretically would be almost infinite. The limit in practice, however, is about 1000 times gravity in commercial machines that are adapted to processing clays. These limitations are imposed principally by a consideration of the strength of the materials available for the construction of the machine.

Figure 3 represents a vertical section through an ordinary horizontal settling box with an inclined bottom. If A–A' is the axis of rotation around which the levigating chamber, B–B', is rotated, a geometric cylinder of revolution is developed. The slurry feed has now become a hollow-shaft feed tube; the settling box has become a frustro-conical centrifuge bowl; and the inner surface of the slip has assumed the form of a cylindrical annulus.

The fine particle slip still overflows at the large end of the tank, and the oversize particles still accumulate on the wall of the bowl.

The slip and the centrifuge elements rotate practically as a unit, and except at the point where the slip enters, there is no more occasion for turbulence in the system than there was before it began to rotate.

(2) Need of Maintenance of Constant Solids and Depositing Conditions

Figure 4 shows that the oversize particles collect on the inner wall of the centrifuge bowl. Under settling forces of 200 to 1000 times gravity, these particles form a firm cake that adheres to the wall. As the centrifuging proceeds, the progressively accumulating coarse particles tend to fill the bowl which reduces its effective volume and thereby decreases its effective solids-depositing capacity.

(3) Maintenance of Constant Volume

Means for removing solids progressively from a conical centrifuge bowl, such as is shown in Fig. 3, are extremely simple in principle. A "screw-conveyer" with its peripheral outlines tapered is fitted concentrically into the centrifuge bowl with barely sufficient clearance to allow it to be rotated slowly therein. If the bowl is rotated at 1000 r.p.m. and the screw conveyer at very nearly the same speed (about 1008 r.p.m.), the coarse particles will be propelled along the wall of the bowl and will be discharged (see Fig. 3). The sand will be propelled toward the small end of the bowl, the water will travel simultaneously toward the large end, and each will be eliminated progressively at opposite ends of the centrifuge.

This is the functional principle of operation of the continuous centrifugal fractionator that was used to make the particle-size separations which have been described.

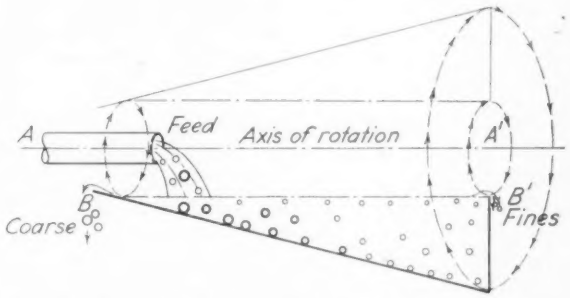

FIG. 3.—Basic similarity of levigation and centrifugal principles of fractionation.

(4) Practical Difficulties of Design

Although the basic principles are simple, the problems of design which are encountered in practice are quite involved.

When fine particles of sand are thrown out of suspension under 500 times gravity, they form a compact and tough cake which adheres tenaciously to the centrifuge wall. If a screw conveyer, 3 ft. in diameter, becomes "enmired" around its entire periphery in such material, torques of extraordinary magnitude are required to rotate it within the centrifuge bowl so that the rejects may be propelled toward their exit ports in the machine.

Such conveyers often require 15 h.p. or more at low speeds of rotation, that is, approximately 9 to 20 r.p.m. The design of gear units, sufficiently rugged to transmit this amount of power at such low speeds and to

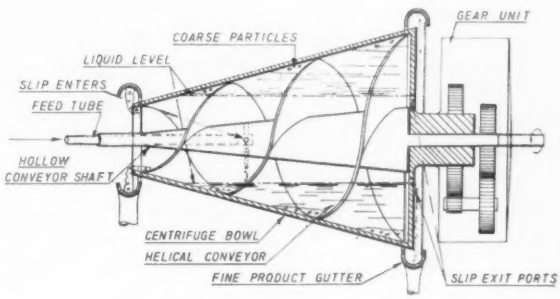

FIG. 4.—Continuous centrifuge.

deliver it while the screw and the bowl are spinning at 1000 to 2000 r.p.m., calls for no ordinary design.

V. Description of Bird Continuous Centrifuge

The continuous centrifuge, which is being used in this country for particle-size control, consists of the following parts: (1) a frustro-conical bowl which spins horizontally; (2) a feed tube to introduce the slip continuously into the sphere of centrifugation; (3) a helical screw conveyer, concentrically disposed within the bowl to propel the rejects toward their point of exit as they accumulate on the inner wall of the bowl; (4) a gear unit to maintain the low rate of differential revolution of the screw within the bowl; (5) a thrust-bearing between the screw and bowl to absorb the reaction developed by the conveyer in propelling the compacted reject particles along the wall of the bowl; and (6) annular gutters at the two ends of the bowl to collect and conduct away the fine particle slip and the oversize reject particles.

(1) Operation of the Centrifuge

The centrifuge bowls are rotated almost universally by electric motor. They were originally equipped with silent chain drives, but these have been superseded by V-belts to give greater flexibility, higher possible speeds, and quieter operation.

The machines are operated usually as constant speed units, and the rotational velocities are changed only when shifting from one grade of product to another of widely different character. Machines may spin at low speeds for ordinary grit removal and as high as 2000 r.p.m. in preparing fine-particle coating clays.

The control of particle size in the production of a given grade of clay is accomplished by regulating the detention period, that is, by controlling the rate of feed of the slip. The speed of rotation is seldom changed, which emphasizes the necessity for precise and reliable means for regulating the rate of feed of the slip to the machines. Simple and effective methods fortunately are available for controlling the flow of material, even for the crude clay slips which may carry a considerable amount of trash, grit, and lumps.

The functional behavior of the machines can be determined by noting the rate of feed and the rotational speed. A further check as well as a calculation of the proportion of the solids being fed (which are rejected as oversize) may be made rapidly by a comparison of the specific gravity of the clay as it is being fed with the specific gravity of the fine particle slip that is emitted by the machine.

The power consumption of a machine is determined by the amount of slip being fed through it, that is, the acceleration of the slip usually requires more power than that needed to rotate the bowl. A centrifuge, 36 in. in diameter, for example, might require 6 h.p. to spin it at 900 r.p.m. without any slip passing through it, but the machine might require 25 h.p. to handle 125 gal. of 30% clay slip per minute. The power consumption per ton from a given crude clay varies with the fineness of product desired; extremely fine particle products, for example, require more power consumption per ton.

The production capacity per centrifuge also varies with fineness. A standard machine may produce 15 tons per hr. of clay of ordinary fineness at 500 r.p.m. but yield only 2 tons per hr. at 1100 r.p.m. of fine-particle coating clay.

(2) Elements of Fractionating Process

A stream of clay slip may be centrifugally split into two components, one below a given particle size and the other of a still finer size. A clay fraction whose particle size is finer than 6 μ and coarser than 2 μ may be obtained as follows: A crude clay slip, containing particles that range from about 100 to 0.1 μ, may be passed first through one centrifuge under conditions that will cause all particles coarser than 6 μ to be rejected. The clay is then passed through another centrifuge that will reject all particles coarser than 2 μ. The rejected particles from the second centrifuging will consist predominantly of particles that range from 6 to 2 μ in size.

This process describes the basic principle of centrifugal fractionation although its unit operations are subject to a variety of permutations and combinations.

(3) Advantages and Disadvantages

These machines and processes have been in daily operation for more than six years so that their inherent qualities may be fairly well evaluated.

Among their disadvantages as compared to conventional methods are (1) a rather high initial cost, (2) a small, but continuous power cost, and (3) reasonably intelligent mechanical supervision from time to time.

They possess several advantages, however, as follows: (1) sharper separations, particularly in the finer particle ranges; (2) easy and rapid control of fractionations; (3) the fractionations have more than average reproducibility; (4) continuous and automatic operation of the units that require practically no supervision; (5) compact production units of high capacity which may be moved easily from one location to another; (6) the addition of dispersing chemicals to the slip is unnecessary; (7) higher slip concentrations may be used than can be fractionated under conventional gravity conditions; (8) the oversize fraction issues progressively from the machine as a solids concentrate whose moisture content compares favorably with that of most filter cakes; and (9) very concentrated slips may be processed when deflocculating chemicals are not objectionable in the product and a high capacity per machine may be obtained.

VI. Conclusions

Subsieve fractionation or particle-size control is an accomplished fact, and clays and certain other ceramic raw materials are now commercially available in a variety of grades of controlled particle size. These materials are not significantly more expensive than the conventionally prepared products and some of the centrifuged materials may probably be cheaper.

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INFLUENCE OF FIRING AND COOLING RATES ON PROPERTIES OF A VITREOUS CHINA BODY*

By A. E. Currier and A. S. Watts

Abstract

Typical vitreous chinaware bodies were prepared and extruded into bars under uniform conditions. The representative specimens of each body were fired to 1280°C. and cooled at three different rates in a Globar-type furnace, which was equipped with every control and was also carefully standardized. The properties of the product are given, and the effect of the firing and cooling treatments is shown.

I. Introduction

A precisely controlled Globar furnace was used in this study. The furnace hearth is 10 by 8 in. in size, and any temperature above 900°F. within ±3°F. may be maintained. The rate of temperature increase and decrease, moreover, is controlled by a float system which is attached to a Wheelco capacitrol.

The test body had the following composition:

	(%)		(%)
Buckingham feldspar	16	Fla. kaolin	10
AA dolomite	1	Ga. kaolin	25
No. 4 Ky. ball clay	10	Flint	38

This body was prepared by the normal slip and filter-press process, and 275 bars, 1 by 1 by 7 in. in size, were extruded from a deairing pug mill.† These bars were air dried, stored, and dried again for 8 hr. at 220°F. before they were fired.

Figure 1 shows the various firing and cooling treatments used on the bars in nine different combinations.

Table I

Firing	Hr.	Cooling	Hr.
FF (fast)	18	FC (fast)	12
" "	"	MC (medium)	18
" "	"	SC (slow)	32
MF (medium)	24	FC (fast)	12
" "	"	MC (medium)	18
" "	"	SC (slow)	32
SF (slow)	42	FC (fast)	12
" "	"	MC (medium)	18
" "	"	SC (slow)	32

These firings were repeated, making 18 firing-cooling curves and 18 sets of trials on which to base conclusions. Ten bars were used for each firing, and these were selected 10 bars apart, such as 1, 11, and 21, so that any possible variation caused by the preparation and forming procedure was reduced to the minimum. All of the bars were tested so that all data are average.

II. Data Obtained

The firing data developed include loss of weight, modulus of rupture, shrinkage, and absorption. For the progressive vitrification studies, absorption data were obtained on the central portion of the bars. The bars were broken, separating the surface and the center portions, to show the progress of heat penetration as it is influenced by the various firing treatments. The absorption tests were run on the entire cross section of the bars broken into $^1/_2$-in. slabs.

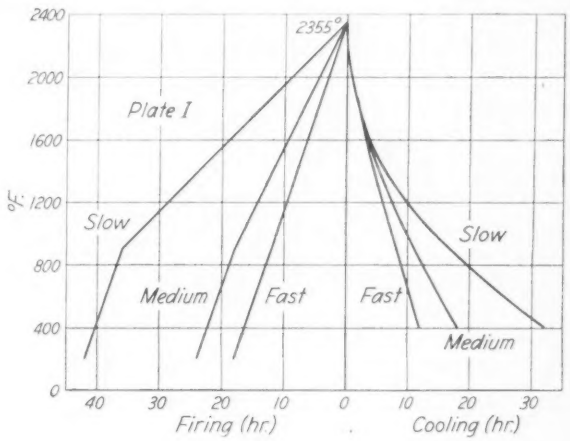

Fig. 1.

In the absorption tests, the specimens were weighed, placed in small beakers, and covered with water to which 0.5% Aresket was added. The beakers were placed under a bell jar and a vacuum of 27.5 in. was held for 1 hr. The specimens remained in the water at room pressure for an additional 2 hr. before they were removed; the surfaces were wiped; and the specimens were reweighed.

III. Conclusions

(1) Constant Firing and Variable Cooling

The shrinkage is essentially the same with medium cooling as with fast cooling, but the slow cooling causes an average shrinkage increase of 2.8% in the fast and slow firings.

The average strength decrease is 5.5% with the medium cooling and 9.0% with the slow cooling.

The average total absorption decrease is 8.7% with the medium cooling and 12.3% with the slow cooling.

(2) Variable Firing and Constant Cooling

The average shrinkage increase is 6.7% with medium firing and 8.9% with slow firing.

* Presented at the Forty-Third Annual Meeting, The American Ceramic Society, Baltimore, Md., April 2, 1941 (White Wares Division). Received May 21, 1941.

† International Clay Machinery Co.

TABLE II

AVERAGE RESULTS

Firing and cooling*	Firing shrinkage (%)	Weight loss (%)	Fired modulus of rupture (lb./sq. in.)	Absorption (%)			
				Total	Interior	Exterior	Interior/-exterior
FF-FC	8.12	6.64	7940	2.93	3.33	2.55	1.31
FF-MC	8.13	6.58	7870	2.62	3.25	2.14	1.51
FF-SC	8.33	6.57	7730	2.55	2.85	1.85	1.54
MF-FC	8.75	6.61	11170	1.64	2.08	1.12	1.86
MF-MC	8.44	6.60	10040	1.87	2.35	1.28	1.83
MF-SC	8.42	6.56	9450	2.00	2.71	1.49	1.81
SF-FC	8.83	6.63	8900	1.38	1.80	0.82	2.20
SF-MC	8.84	6.61	10650	1.26	1.63	0.82	2.00
SF-SC	9.11	6.60	10890	1.22	1.59	0.67	2.37
FF-FC	8.12	6.64	7940	2.93	3.33	2.55	1.31
MF-FC	8.75	6.61	11170	1.64	2.08	1.12	1.86
SF-FC	8.83	6.63	8900	1.38	1.80	0.82	2.20
FF-MC	8.13	6.58	7870	2.62	3.25	2.14	1.51
MF-MC	8.44	6.60	10040	1.87	2.35	1.28	1.83
SF-MC	8.84	6.61	10650	1.26	1.63	0.82	2.00
FF-SC	8.33	6.57	7730	2.55	2.85	1.85	1.54
MF-SC	8.42	6.56	9450	2.00	2.71	1.49	1.81
SF-SC	9.11	6.60	10890	1.22	1.59	0.67	2.37

Water of plasticity = 22.3%; drying shrinkage = 4.17%; and dry modulus of rupture = 330 lb./sq. in.

* Firing and cooling data throughout are as follows:

FF (fast firing), 18 hr.	FC (fast cooling), 12 hr.
MF (medium "), 24 "	MC (medium "), 18 "
SF (slow "), 42 "	SC (slow "), 32 "

The strength increase is 29.7% with medium firing and 38.1% with slow firing (excluding the fast cooling).

The average absorption decrease is 31.1% with medium firing and 52.3% with slow firing.

It is seen from these data that most of the increased shrinkage and decreased strength and absorption in general occur in the time between the fast and medium cooling periods. Most of the differences in the firing likewise occur in the time between the fast and medium firing. This is checked by the cone deformation data obtained for these firing schedules. By firing to the same temperature at the different rates, the cone values were as follows:

Firing (hr.)	Cone No.
6	10^3
18	11^6, 12^2
24	12^4, 13^2
42	12^5, 13^3

This indicates that the changes in values obtained in the 6-hr. period between the fast- and medium-firing schedules are large when compared with those obtained in the 18-hr. period between the medium- and slow-firing schedules. This shows that an extension of firing time beyond 24 hr. would not be nearly as beneficial as to increase the firing temperature a few degrees.

It is interesting to note that the results of variable firing show less difference between the fast and medium firing schedule as the length of cooling time increases. If these differences, therefore, are to be minimized, the cooling rate should be decreased or it should be increased if the differences are to be accentuated. The results of the variable firing schedule between fast and slow firing time are not greatly affected by the cooling rate.

The data on the firing weight loss show no appreciable change with a variation of firing or cooling.

From the data on absorption of the outside and inside portions of the trials, it is apparent that the longer the firing or the cooling periods, the greater is the difference between the absorption of the exterior and interior parts of the samples. This conclusion, which is contrary to popular impression, requires a critical study of the effect of variable firing and cooling treatments on the character of the glassy phase of the body. The increased vitrification that occurs with the longer firing

TABLE III

SHRINKAGE, MODULUS OF RUPTURE, AND ABSORPTION RESULTS

	Variable cool (%)	Variable fire (%)
Shrinkage		
Medium vs. fast	FF = 0.12*	FC = 8.4*
	MF = 3.5†	MC = 3.8
	SF = 0.11*	SC = 1.1
Slow vs. fast	FF = 2.6*	FC = 8.7*
	MF = 3.8†	MC = 8.7
	SF = 3.1*	SC = 9.4
Fired modulus of rupture		
Medium vs. fast	FF = 0.88†	FC = 39.4*
	MF = 10.10†	MC = 27.6
	SF = 19.80*	SC = 22.2
Slow vs. fast	FF = 2.65†	FC = 0.67*
	MF = 15.40†	MC = 35.40
	SF = 22.30*	SC = 40.80
Total absorption		
Medium vs. fast	FF = 10.6†	FC = 44.0†
	MF = 14.0*	MC = 28.0
	SF = 8.8†	SC = 21.4
Slow vs. fast	FF = 13.0†	FC = 52.8†
	MF = 21.9*	MC = 52.0
	SF = 11.6†	SC = 52.2

* Increase.
† Decrease.

and cooling treatments must be attained in the faster firing and cooling treatments at high temperatures, which may or may not affect the variation in absorption between the outside and the interior portions of the body.

The results of constant firing and variable cooling show that in two out of three of the firing tests the shrinkage increases, the modulus of rupture decreases, and the absorption decreases with a longer cooling period. The medium-firing rate is inconsistent with the shrinkage and absorption results, and the slow-firing schedule is contrary to expectations as to the modulus of rupture results. No explanation has been found for these irregularities.

The results of the variable firing and constant cooling schedule show definitely that the firing shrinkage and modulus of rupture increase and that the absorption decreases with a longer firing time when the same final temperature is attained.

From the evidence developed in this study, the benefits of a 24-hr. firing period over an 18-hr. schedule are much greater than the benefits of a 42-hr. firing over a 24-hr. rate. The benefits derived from an 18-hr. cooling period over 12 hr. are also greater than those of a 32-hr. over an 18-hr. cooling time. This conclusion indicates that moderate firing rates and cooling rates have definite advantages over either a faster or a slower treatment.

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PRACTICAL APPLICATION OF AUTOMATIC HEAT AND HUMIDITY CONTROLS TO DRIERS*

By R. R. Robinson

Abstract

The fundamental principles of drying ceramic ware are discussed and practical methods of applying automatic controls to the heat and moisture supply in existing driers are described. These applications were made (1) to the continuous tunnel drier in which the ware passes progressively through the drier from one set of air and moisture conditions to another and (2) to the batch drier in which the ware remains stationary and the air and moisture conditions are changed as the drying progresses.

I. Introduction

The more rapidly water vapor is removed from drying ceramic ware, the higher will be the rate of evaporation provided the temperature of the ware remains constant. The tendency for the surface of the ware to rupture during drying will vary according to the differential between the vapor pressure inside the ware and that of the surrounding atmosphere.

If wet ceramic ware is heated to 110°F., the resultant water vapor within the ware could attain a pressure of 2.6 in. of mercury or, approximately, 1.28 lb. per sq. in. If, at the same time, the atmosphere surrounding the ware had a dry-bulb temperature of 110°F. and a wet-bulb temperature of 92°F. or a relative humidity of 50%, the vapor pressure in the atmosphere would be 1.3 in. of mercury or 0.64 lb. per sq. in. The difference between the internal and external pressure, that is, 0.64 lb. per sq. in., would create a flow of vapor which, if it were required to pass through a nonplastic surface layer, would develop fissures in that surface. If, however, the atmosphere of the drier had a dry-bulb temperature of 110°F. and wet-bulb temperature of 103°F., or about 79% of relative humidity, the vapor pressure of the atmosphere would be about 2.1 in. of mercury or 1.032 lb. per sq. in. There would thus be a difference of 0.248 lb. per sq. in. between the pressure within the body and that of the atmosphere surrounding the ware.

For quantity production of structural shapes, the problems to be solved are (1) an economic supply of heat for drying, (2) the maintenance of the plasticity of the body surface until the ware is heated throughout, and (3) a sufficient supply of air to carry away the water vapor.

II. Types of Driers Used

The types of driers in general use are (1) the continuous tunnel drier through which the ware passes progressively from one set of air and moisture conditions to another and (2) the batch drier in which the ware remains stationary and the air and moisture conditions change.

(1) Continuous Tunnel Driers

In the continuous tunnel driers, it is assumed that the constant evaporation of water will humidify the air as the ceramic ware absorbs heat and that the relative humidity of the air will increase as it flows toward the cooler end of the tunnels. The air, however, neither flows in uniform quantities nor with uniform entering temperatures, nor does the ware pass continuously through the tunnels. The purpose for which the driers

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were built is therefore being constantly defeated. Table I shows the changes in relative humidity and other conditions of the drier atmosphere when the temperature and humidity of the outside atmosphere change.

By placing a fan at the cool end of a tunnel drier and thereby passing the drier air through a duct system to the center of the tunnels, uniform relative humidity may be maintained at various stages to the point of saturation. When the temperature in the cooler end of the drier increases beyond the desirable point, a small propeller fan is used to introduce cooler air from the atmosphere. To obtain sensitive control for this system, a wet- and dry-bulb controller instrument is so placed that the thermometer elements are in the air stream that flows from the driers. This instrument controls the valves in a compressed-air system which operates (1) the air motors that open and close the louvres, (2) a steam valve, and (3) an electric switch for the small air-tempering fan. A continuous record of the temperatures is kept by the control instrument.

In addition to the equipment described, for continuous driers heated by waste heat, a dry-bulb controller is installed near the supply fan. This instrument controls the set of louvres, which admits fresh air for cooling at the fan intake as well as the set of louvres which regulates the quantity of air flowing into the drier. A continuous record of the temperature of the air entering the drier is kept by the instrument. Figures 2 and 3 show the possibilities of controlling the temperatures at the cooler end of the drier when there is great variation in temperature at the hot end.

In one of the radiated-heat type of driers, the loss for special shapes consisting of hollow facing tile was reduced from 10 to 0.48%, and the production of the drier was increased by 30%. In two waste-heat continuous tunnel driers producing hollow facing tile, the

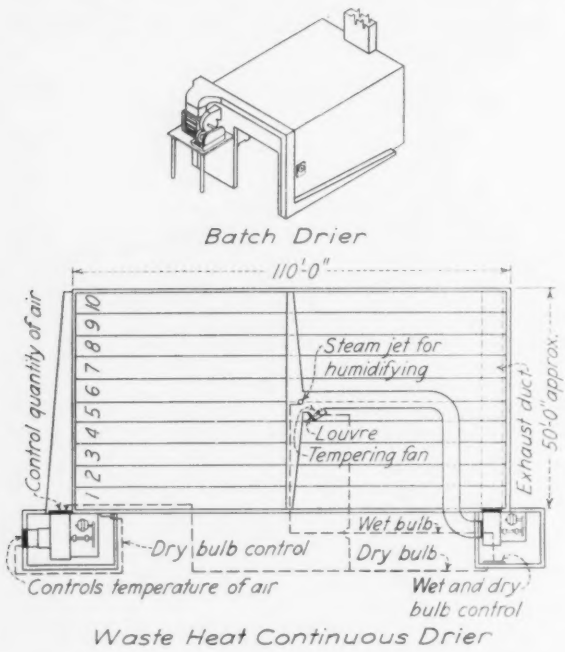

FIG. 1.

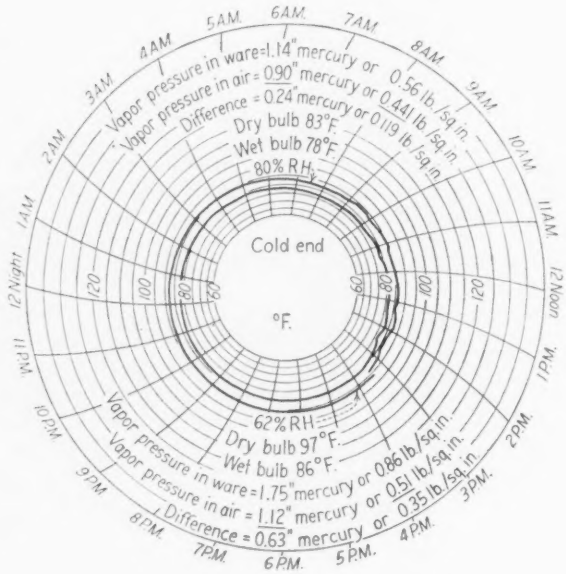
Vapor pressure in ware=1.14" mercury or 0.56 lb./sq.in.
Vapor pressure in air = 0.90" mercury or 0.441 lb./sq.in.
Difference = 0.24" mercury or 0.119 lb./sq.in.
Dry bulb 83°F.
Wet bulb 78°F.
80% RH.
Cold end
°F.
62% RH.
Dry bulb 97°F.
Wet bulb 86°F.
Vapor pressure in ware=1.75" mercury or 0.86 lb./sq.in.
Vapor pressure in air = 1.12" mercury or 0.51 lb./sq.in.
Difference = 0.63" mercury or 0.35 lb./sq.in.
5AM. 6AM. 7AM. 8AM. 9AM. 10AM. 11AM. 12Noon 1PM. 2PM. 3PM. 4PM. 5PM. 6PM. 7PM. 8PM. 9PM. 10PM. 11PM. 12Night 1AM. 2AM. 3AM. 4AM.

FIG. 2.

TABLE I

AIR REQUIRED AND VARIATION IN DRIER AIR CONDITIONS WHEN ATMOSPHERIC CONDITIONS VARY AND TWO DRIER TEMPERATURES ARE USED

No. of brick dried, 50,000/24 hr.; weight, 5 lb. wet, 4.25 lb. dry; No. per car, 500; water removed from air, 37,500 lb.; water removed from air/min., 26.04 lb.

Temp. (°C.)				Air required (lb./-min.)	Cu. ft./-min. at drier temp.§	H_2O (lb./min.) from		Temp. cold end (°C.)			Vapor pressure (in. of Hg)		Difference in pressure	
Drier	Atmospheric DB*	Atmospheric WB†	RH (%)‡			Atmosphere	Drier	DB*	WB†	RH (%)‡	Drier atmosphere	In brick	(in. of Hg)	(lb./sq.in.)
300	90	90	100	882	20100	27.42	53.46	110	110.0	100	2.6	2.6	0	0
300	90	71	39	882	20100	10.55	37.59	110	101.5	74	1.95	2.6	0.65	0.319
300	40	40	100	882	20100	4.65	30.69	110	96.5	61	1.60	2.6	1.0	0.49
200	90	90	100	1392	23150	41.60	67.64	110	104.5	82	2.15	2.6	0.45	0.221
200	90	71	39	1392	23150	16.68	42.72	110	94.0	53	1.40	2.6	1.26	0.619
200	40	40	100	1392	23150	7.34	33.38	110	88.0	42	1.10	2.6	1.50	0.738

* DB, dry-bulb temp. † WB, wet-bulb temp. ‡ RH, relative humidity.

Atmospheric temperature is assumed, e.g., pounds of air required and cu. ft. per minute are approximated to within 2 or 3%; drop of temperature in drier depends on constant flow of ware with uniform water content.

§ Drier temp., 300°F. for 20,100 cu. ft./min. and 200°F. for 23,150 cu. ft./min.

losses were reduced from 15 to 0.5% with an increase in production of 15 to 20%. The kiln losses in ware from both types of driers, furthermore, were reduced when the drier losses decreased.

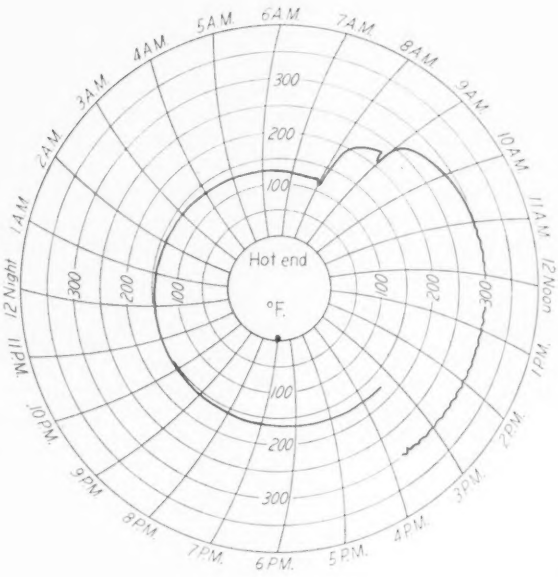

FIG. 3.

(2) Batch Driers

In batch drying, clay shapes are placed in a confined space and protected from drafts of air until the ware is dry.

In a plant that manufactures open-hearth sleeves and nozzles from Pennsylvania fire clay, a compartment was built in the regular drying room which was 8 ft. high and occupied 640 sq. ft. of floor space. A set of ducts (one on each side of the compartment) conducted the air to a fan centrally located at one end of the compartment. The fan discharged the recirculated air through a set of steam-heating coils into the compartment above the ware and exhausted the air from each side at the bottom of the drier. Provision was made to introduce vapor into the air stream.

During the first trial drying, the ware was placed on the floor (on end and two sleeves high) as close together as possible, so that there were approximately 2600 sleeves, each weighing 19.1 lb. wet or 16.6 lb. dry, in the drying compartment. The open end of the compartment was closed with a roll curtain of heavy canvas. The compartment was heated to 110°F. for one-half hour by convection from the steam coils. The fan then recirculated the air until the ware was heated to 120°F., which required 3 hr. The louvres were opened to admit fresh air, and the temperature of the heating coils was raised to supply heat for the incoming air. The temperature of the drier was raised uniformly over a period of 6 hr. to 200°F., while part of the vapor escaped from a stack in the drier opposite the fan. When the temperature reached 200°F., the fan continued to supply fresh air until the ware was completely dry. The total drying time was 72 hr.

The ware was found to be free of warping and cracks in spite of the short drying period; the time required by the other methods is usually 144 hr.; the amount of heat required was approximately 52,600 B.t.u. per hr.

It was necessary to control the system manually until the drying cycle was established. After one week of testing, this drier produced 100% more ware than the amount dried in the same space when other methods were used, and the ware was dried in 72 hr. instead of 144 hr. Two more compartments are now being constructed in the same drying room. This method of building compartments on ordinary drying floors releases floor space and also increases production without increasing the total cost of the heat used for drying the ware.

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USE OF PHOSPHATE OPACIFYING AGENTS IN SANITARY-WARE GLAZES*

By W. H. Earhart

Abstract

Several different water-insoluble phosphates were introduced separately into two raw, leadless sanitary-ware glazes, one with a high alkali content and the other with a low alkali content. Satisfactory opacity and white color were obtained with tricalcium, trizinc, and trimagnesium phosphates as well as with calcium pyrophosphate. Lead phosphate was ineffective in the low alkali glaze and produced opalescence in the glaze high in alkali. Aluminum phosphate ruined the low alkali glaze, but opacified the glaze high in alkali. Calcium pyrophosphate in a commercial low-alkali glaze produced a color, opacity, and texture that was indistinguishable from the same glaze opacified with tin oxide, and repeated firings through the kiln did not alter the glaze appearance. Tricalcium phosphate and calcium pyrophosphate did not produce any opacity in commercial raw lead, fritted lead, or fritted leadless glazes that matured at cone 6 or lower.

I. Introduction

The use of tin oxide has long been recognized as the most satisfactory and universally applicable opacifying agent in ceramic glazes. Its relatively rare occurrence and important metallurgic applications, however, make its use by the ceramist expensive, particularly at the present time when tin is classed as a strategic raw material. Many substitutes, chiefly various compounds of zirconium, titanium, or antimony, have been developed successfully and are in commercial use today, but they are expensive and usually require certain precautions in their application. Rare earth compounds have been proposed, but they also are expensive because of their rarity.

The writer, therefore, proposes the use of phosphates as opacifying agents in ceramic glazes, especially in certain types of sanitary-ware glazes. The phosphates are as effective in these glazes as tin oxide or other substitutes, and they also possess marked advantages of price, purity, and availability. Tricalcium phosphate (not bone ash) may be purchased in carload lots at a cost of about 7¢ per lb.; it is said to contain less than 20 parts of iron oxide in one million parts of phosphate (less than 0.002% of iron oxide). If this chemical is used to replace tin oxide, a saving of 50¢ per lb. over the cost of the tin is represented. A sanitary-ware plant using 2000 lb. of tin oxide each month would effect a savings of $1000 on this quantity.

II. Experimental

In the raw, leadless sanitary-ware glazes that mature at cone 8 or higher, a direct replacement of tin oxide by phosphates resulted in satisfactory color, permanent opacity, brilliance, and texture. Two trial glazes, each with a marked difference in alkali content, were chosen for the tests. One glaze was representative of the class of leadless glazes with a low alkali content and the other had an alkali content as high as generally is used in practice; the glazes with an intermediate alkali content were assumed to give an intermediate range of results. The molecular and batch formulas used were as follows:

Molecular formula No. 1				Batch formula (%)	
				No. 1	No. 2
0.15 KNaO 0.50 CaO 0.25 ZnO 0.10 MgO	0.35 Al_2O_3	3.0 SiO_2 0.1 B_2O_3	Flint	34.37	17.7
			Feldspar	16.75	52.9
			EPK kaolin		5.4
			Kamec kaolin	19.42	
			Zinc oxide	6.10	5.5
			Ga. whiting	12.05	14.3
			Dolomite	5.56	
			Talc		4.2
			Borax	5.76	
				100.01	100.0
No. 2					
0.28 KNaO 0.42 CaO 0.20 ZnO 0.10 MgO	0.34 Al_2O_3	2.8 SiO_2	Opacifier	+4.00	+4.0

All glaze trials were fired to cone 11 in a commercial tunnel kiln operating on a 60-hour cycle. In order to obtain comparable results, the amount of phosphate used in each glaze was held at 4.0%. The following phosphates were tested separately:

Tricalcium phosphate	$Ca_3(PO_4)_2$	Zinc phosphate	$Zn_3(PO_4)_2$
Calcium pyrophosphate	$Ca_2P_2O_7$	Aluminum phosphate	$AlPO_4$
Trimagnesium phosphate	$Mg_3(PO_4)_2$	Lead phosphate	$Pb_3(PO_4)_2$

The use of these phosphates in glaze No. 1 resulted in good opacity and color except for the aluminum compound, which produced a very rough, unfused, mat surface, and the lead phosphate, which gave a fine glaze but no opacity. With glaze No. 2, all of the phosphates were satisfactory except lead phosphate, which produced opalescence with the 4% concentration used.

When tested as a direct substitute for tin oxide in a commercial sanitary-ware glaze similar to glaze No. 1, calcium pyrophosphate was fully as satisfactory as the tin oxide. An experienced observer, in fact, was unable to distinguish one glaze from the other. Repeated firings of this glaze, moreover, did not affect the glaze appearance.

The mineral phosphates were not investigated, inasmuch as they were believed to vary in composition and purity. It was felt that the essential information could be obtained by relying on definite chemical compounds,

* Presented at the Forty-Third Annual Meeting, The American Ceramic Society, Baltimore, Md., April 2, 1941 (White Wares Division). Received April 7, 1941.

and these results would also be applicable to the mineral phosphates.

The water-soluble phosphates were not investigated because of the adverse reactions which these compounds have on the clay portion of the glaze batch. Tetrasodium pyrophosphate, for example, would deflocculate the glaze, whereas sodium dihydrogen or other soluble hydrogen phosphates would cause coagulation because of their acid character. If these phosphates were incorporated in the fritted portion of glazes, however, they might function satisfactorily.

Glaze-fit tests were not made with any of the preceding trials, and therefore the effect of the phosphate opacifiers on this property was not determined.

When tricalcium phosphate and calcium pyrophosphate were introduced into commercial raw lead, fritted lead, and fritted leadless glazes that mature from cones 2 to 6, no opacifying action was observed. These glaze compositions could not be obtained, but the lime content probably was insufficient so that the glaze components were able to acquire lime by solution of the lime phosphate. Satisfactory opacity could possibly have been obtained by using other phosphates which the glaze may not attack as readily (for example, lead, zinc, or magnesium phosphates); these phosphates, however, would be more expensive than the calcium compounds.

III. Conclusion

The purpose of this study was to point out the economic advantages and ceramic possibilities of using phosphates as opacifying agents in glazes. The technical and commercial applications, however, will have to be treated individually to meet the requirements of each glaze composition, the firing conditions, and the colors.

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NOTES ON CASTING *

By Girard W. Phelps

Abstract

A brief discussion is given of several factors affecting the castability of body slips and methods for the determination of data for them. An illustrative problem shows the application of such data to the rapid solution of casting problems.

I. Introduction

The properties of casting slips and the factors affecting them have been studied in considerable detail by a number of workers. Hall,[1] in 1930, published a résumé of the material then extant, and since that time investigations by Schramm and Hall[2] and Loomis[3] have added to knowledge on the subject. Schramm and Hall studied the effect of variable specific gravity and consistency on the castability, and Loomis attempted to correlate the effect of grain size and pH versus consistency and casting rate. Of the various factors affecting castability, some of the more important are particle size, pH of body materials, consistency, specific gravity, castability, soluble salt content, and base-exchange capacity.

II. Test Procedures

It was found best to rely on tests on (1) particle size, (2) pH, (3) casting rate under standard conditions, and (4) green strength and drying shrinkage.

(1) Particle Size

Grain-size patterns were made by using a modification of the pipette method described by Robinson.[4]

(2) Hydrogen-Ion Measurement

Hydrogen-ion values were determined with a glass electrode and Beckman pH meter on 5% suspensions of clay in freshly boiled, distilled water.†

(3) Casting Rate

The clays were dried carefully and made into casting slips as follows: 1000 gm. of clay were mixed with 1000 gm. of 200-mesh flint, 700 gm. of water, and 6 gm. of deflocculant (consisting of 6 parts of *N*-brand sodium silicate and 4 parts of c.p. sodium carbonate) were added. The slip was blunged for 2 hours in a slow-speed mixer, screened through an 80-mesh sieve, and stored for 24 hr. before testing. At the end of the aging period, the quality of the slip was tested, with particular attention to settling and livering. The slip was again stirred and poured into test molds. The molds were simple plaster cylinders with a cone-shaped interior and a drain hole in the bottom. These were set up on racks, the drain holes were plugged, and the

* Presented at the Forty-Third Annual Meeting, The American Ceramic Society, Baltimore, Md., April 2, 1941 (Art Division). Received April 3, 1941.

[1] F. P. Hall, "Casting of Clayware, a Résumé," *Jour. Amer. Ceram. Soc.*, **13** [10] 751–66 (1930).

[2] Edward Schramm and F. P. Hall, "Notes on Casting Slip," *ibid.*, **17** [9] 262–67 (1934).

[3] G. A. Loomis, "Properties of Clay Casting Slips," *ibid.*, **23** [6] 159–62 (1940).

[4] G. W. Robinson, "New Method for Mechanical Analysis of Soils and Other Dispersions," *Jour. Agri. Sci.*, **12** [306] (1922).

† Method of J. M. Huber Co., Inc.

slip was poured in; at the end of the desired casting time, the plug was removed, and the slip was allowed to drain into the containers. Three casts were generally made for each slip, using a casting time of 5, 10, and 20 minutes, respectively. The casts were removed in a leather-hard condition, cut vertically into halves, and thoroughly air dried. Casting rates were computed by measuring the thicknesses of the dried casts and plotting these against time.

(4) Strength and Shrinkage

Experiments on the green strength were made from slips prepared as described before and cast in simple bar molds. The bars were allowed to stand for 12 hr. in the molds before they were removed; they were then air-dried for 2 days, oven-dried for 2 hr. at 105°C., cooled in a desiccator, and broken on a transverse breaking machine. Shrinkage measurements were made on pieces cast solid in a disk mold marked with 5-cm. shrinkage marks.

III. Discussion of Tests

In the foregoing process, little attention is actually paid to the particle-size and hydrogen-ion data because it has been possible to relate these characteristics to casting quality only in a very general manner. On this basis, for example, a fine china clay with a pH of 5.00 and a particle size of 39.0% finer than 0.5 micron was similar to a light ball clay with a pH of 4.95 and a particle size of 40.0% less than 0.5 micron, but their respective casting qualities were quite different. The china clay responded very slowly to deflocculants, jelled rapidly, and gave a slow cast; the ball clay responded readily to deflocculants, jelled much less rapidly, and gave a firm thick wall with a comparatively short casting time. These data were used therefore only in a preliminary study of clay characteristics.

IV. An Illustrative Problem

The effect of various clays on the nature of a casting body was illustrated recently in the manufacture of artware. The casting body consisted essentially of 50% of plastic and 50% of nonplastic material; the ratio of the ball clay to china clay was approximately 3 to 4. In the interest of strength and color, a fine-grained plastic kaolin was introduced to supplement the dark ball clay employed. In the course of a preliminary investigation, an attempt was made to deflocculate the body with the following results: (*a*) to secure proper fluidity with a reasonable quantity of deflocculant, the water requirement was in excess of 50%; (*b*) with just enough water to give proper weight to a slip, a sodium silicate-sodium carbonate deflocculant in the ratio of 6 to 4 failed to give satisfactory fluidity in amounts up to $1^1/_2$% of the dry body weight; (*c*) what appeared to be fast casting proved merely to be a quick jelling action with actually only a very thin wall after 1 hour of casting time; (*d*) draining was naturally quite slow, and the movement of the slip tended to pull the wall away from the plaster; and (*e*) a green piece, apparently in leather-hard condition, fingermarked badly when it was taken from the mold and it slumped when it was jarred.

An inspection of the formula indicated that the green strength of the body, on the basis of the component data, was far in excess of the actual need, and because the shrinkage requirements were not especially stringent, the only real problem involved was to produce a white-firing body which could be cast rapidly and with ease.

Three alternative lines of approach were (1) a different ball clay could be used (a coarser particle size and, other things being equal, faster casting); (2) a coarser china clay could be substituted entirely or in part for the original fine-grained kaolin; or (3) both processes could be used.

Two china clays and a light ball clay were therefore selected for further trial. The ball clay was chosen because, in tests similar to those previously described, it had been found to be fast casting and to have a marked response to deflocculants. The china clays were coarse grained and medium fine grained, respectively. One half of the original ball-clay component was replaced by an equal quantity of the light fast-casting ball clay. This change relieved the livering tendency somewhat, but it was evident that even a complete exchange would not entirely remedy the trouble.

The effect of a combination of china clays was then studied, and a triaxial field was laid out. Three end points were prepared which differed only in the type of china clay used. Point *A* contained a coarse-grained china clay whose pattern was similar to that of English clays; point *B* had a medium fine-grained material; and point *C*, a fine-grained plastic kaolin. These were made into slips by the addition of 35% of water and 0.3% of a 6 to 4 deflocculant and were blunged as previously described. Twelve intermediate points were blended from the end points, and their characteristics were carefully studied.

The end of the field nearest point *C* consisted of a series of impossible bodies which were fluid enough when they were freshly stirred, but they jelled rapidly in the mold and were generally objectionable. This condition, however, was much less pronounced along the binary line connecting points *A* and *C* than along that line between *B* and *C*, inasmuch as *A* showed practically no tendency to jell whereas *B*, on standing, jelled appreciably.

After a careful consideration of the character of the various blends, the fine-grained plastic kaolin was eliminated entirely from the formula and only the moderately fine-grained and coarse-grained clays were used.

The body finally chosen for plant trial contained the basic body used in the foregoing end points plus china clays in the ratio of 1 part medium-fine to 2 parts coarse-grained clay. This body proved to be an excellent casting formula, fast, firm, with no jelling and easily drained and dressed. There was good plastic strength, and as a result, the manufacturer was able to simplify the process and cast the figure whole, whereas it had been previously cast in sections.

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- From 1938 to 1940, Manufacturers Increased by 41% Their Research Personnel
- They Are Investing 0.6% of Total Sales or 6.0% of Net Income in Research
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Who Keep Informed of World's Rapid Science and Product Advances By Literature and Meetings

- Membership in The American Ceramic Society Is an Opportunity for Ceramists

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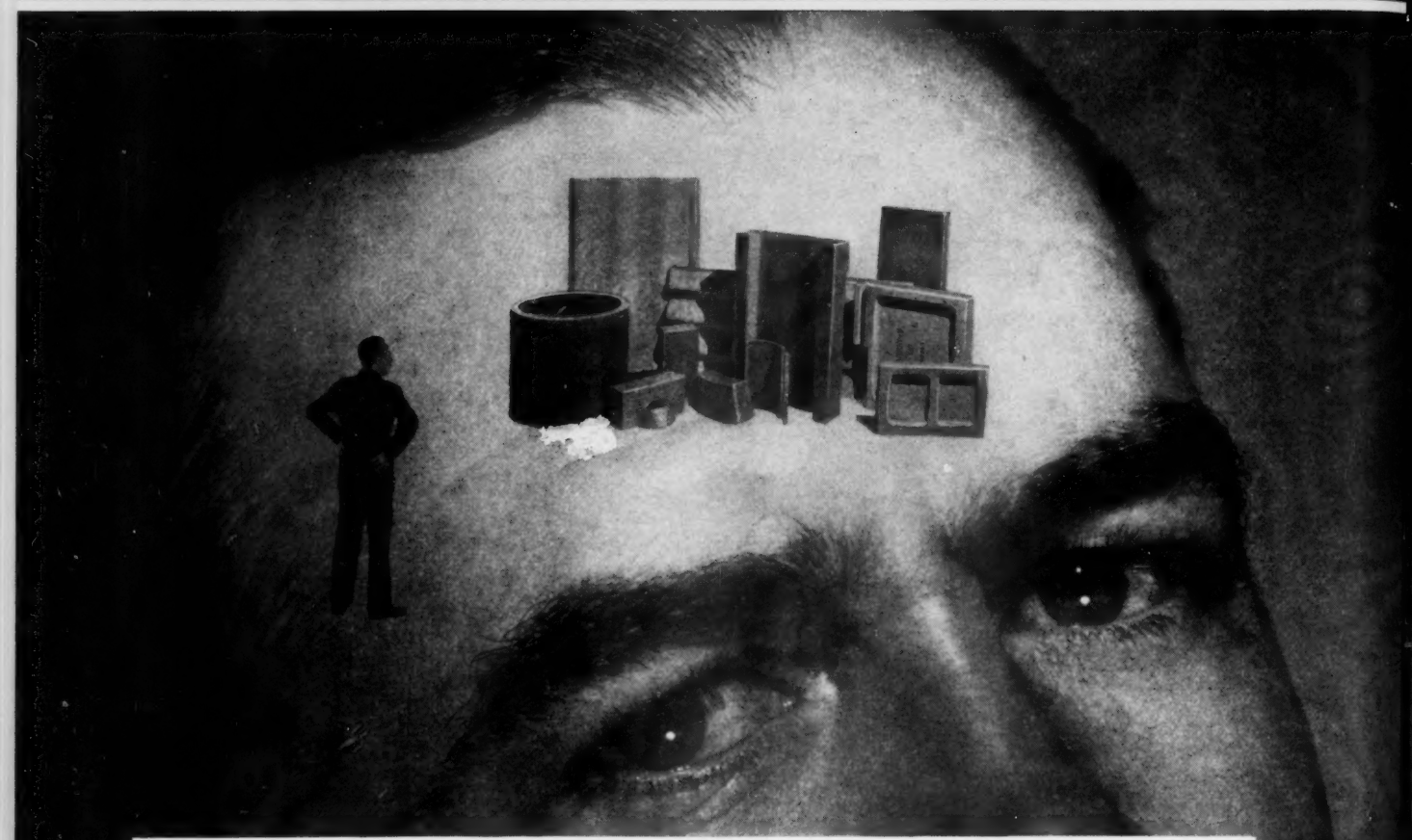
Date of Record	Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
December 20, 1940	1995	260	25	574	220	3074
January 20, 1941	2007	262	27	594	220	3110
March 10, 1941	2023	257	26	620	220	3146
April 21, 1941	1794	247	47	563	220	2871
May 21, 1941	1839	249	47	580	220	2935
June 21, 1941	1875	249	45	584	220	2973
July 21, 1941	1898	251	46	587	220	3002
August 21, 1941	1935	253	45	590	220	3043

USE OUR HEAD



You naturally use *your* head before buying refractory products. Grains, shapes, mixtures are not enough. It also takes brains to create products of maximum usefulness.

So do we use our head before *selling* a refractory product. When you buy from Norton, you use *our* heads, too.

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No reflection on consultants — but this one, called in to check a continuous enameling furnace in New England, learned a lot about performance of ALUNDUM linings. Hearing that the lining had been in constant use for two years, he recommended that production be stopped, the lining removed and replaced with a material he preferred. They did stop production, but found the lining in perfect condition. It's still on the job.

WHEN YOU WANT LONGER-LIVED REFRACTORY PRODUCTS

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1. excellent refractoriness (up to 1600° C.)
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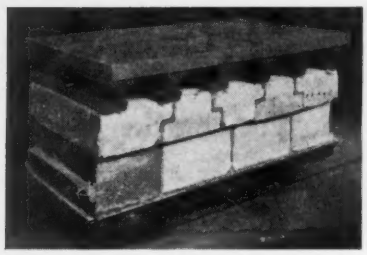

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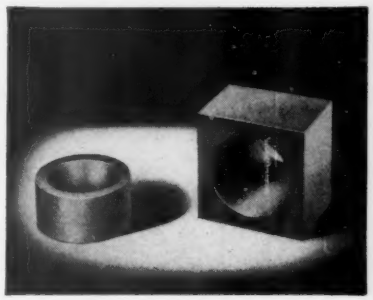

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WILL BE PUBLISHED IN THE OCTOBER BULLETIN

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CERAMIC HISTORY

WILLIAM LLOYD EVANS*

BY WILLIAM MCPHERSON

In the late sixties of the last century, a sterling couple, Evans by name, migrated from their native land of Wales to the United States with the intention of spending the remainder of their lives in this country. After a year in Kansas, they went to Columbus, Ohio, where they found many Welsh friends. Here they remained, highly respected citizens, and here, in 1870, was born to them a son, christened William Lloyd, destined to become one of the leading chemists of our country and president of the American Chemical Society.

The life of William Lloyd Evans has been bound up largely with the Ohio State University. Not only he, but his wife, Cora Ruth Roberts, and their three children, Lloyd Roberts, Jane Anne, and William Arthur, are all graduates of the University.

Dr. Evans' outstanding record as a student and his warm friendship for the late Edward Orton, Jr., who established at the university the first Department of Ceramics in the United States, brought to him, upon graduation, the position of chemist with the American Encaustic Tile Company, at Zanesville, Ohio, and later a fellowship and then an assistantship in the Department of Ceramics at his alma mater.

Dr. Evans' desire to become a teacher of chemistry, as well as his longing to see something of the great West soon took him, however, to Colorado where he spent four years as teacher of chemistry in the Colorado Springs High School. His ambition to know more of the science to which he had become devoted then called him to the University of Chicago, where he spent three years in study and research under that great master, John Ulric Nef. It was there that Dr. Evans began his investigations in the field of carbohydrates, which he has pursued throughout his subsequent university life and which have gained for him the reputation of being one of the leading authorities in this important field of chemical research.

After receiving his Ph.D. degree from the University of Chicago, Dr. Evans returned to the Ohio State University as assistant professor of chemistry. He gradually advanced through the higher ranks until, in 1928, he became chairman of the Department, a position which he holds at the present time.

Dr. Evans is one of those comparatively rare individuals who are equally great both as investigators and as teachers. During his university life at Ohio State, he has directed the research work of more than fifty students who were candidates for the Ph.D. degree. Almost without exception, these graduates today are filling important positions, either as members of the faculties of leading colleges and universities or as members of the research staffs of our great industrial organizations. He has published more than sixty articles in scientific journals, chiefly the *Journal of the American Chemical Society*, giving the results of his investigations in the field of carbohydrate chemistry.

Dr. Evans' interests, however, have not been confined to research work. He always loved to teach, and he has long been recognized as one of the outstanding teachers of his alma mater. Many of the Ph.D. graduates of our universities today seem to think it beneath their dignity to teach the introductory course in chemistry, but Dr. Evans, like such great chemists as Ira Remsen and Edgar F. Smith, has always considered it one of his greatest privileges to direct the work of students just beginning the study of chemistry. Throughout his entire connection with the Ohio State University, he has lectured to the first-year students in chemistry and has helped direct their laboratory work. It is entirely within the bounds of truth to say that more than 40,000 students have had at least a year's training in chemistry under his wise and inspiring leadership.

Neither have Dr. Evans' interests been confined to the Department of Chemistry; he has taken an active part in all that pertains to the welfare of the University. He has been a member of the Graduate Council as well as of many important committees and president of the University Faculty Club.

Dr. Evans naturally is a member of many scientific organizations, including the American Chemical Society, American Association for the Advancement of Science, the Ohio Academy of Science (president, 1940), and the Engineers' Club of Dayton, Ohio. He joined the American Chemical Society in 1907 and has always taken a deep interest in its various activities, having been chairman of the Division of Organic Chemistry (1928), member of the Executive Committee of the Division of Organic Chemistry (1929), and Councillor-at-Large (1934–1936). Under the auspices of the National Research Council, he has been a member of the Committee on Carbohydrate Research (1926–1927), a member of the Committee of Chemistry and Chemical Technology (1934–1940), and a delegate to the Tenth Congress of the International Union of Chemistry held at Liège, Belgium, in 1930.

Many honors have been bestowed on Dr. Evans, including the award of the William H. Nichols Medal (1929) and election as Fellow of the American Academy of Arts and

* Reprinted from *News Ed.* (Amer. Chem. Soc.), **18** [24] 118–19 (December, 1940).

Sciences (1940). He has also been elected to a number of honorary fraternities, including Phi Beta Kappa, Sigma Xi, Phi Lambda Upsilon, and Gamma Alpha.

Dr. Evans' interest in military affairs began in his student days, when he was captain of the prize company and, in his senior year, lieutenant-colonel in the University battalion. During the World War, he was head of the Laboratory and Inspection Division at Edgewood Arsenal with the rank of major.

To know Dr. Evans at his best, however, one must visit him and Mrs. Evans in their home, a home that radiates hospitality and good will to all who enter its doors. It has been their custom for many years to receive the large staff of the chemistry department as well as the scholars and fellows, a custom greatly appreciated by all. From their Welsh ancestors, the members of the family have inherited their love of music; and many of Dr. Evans' students will recall with great pleasure an evening spent in their home with Mrs. Evans at the piano, Dr. Evans with his violin, and their children joining in songs. All of the family are active members of the Congregational church, add much to the success of the musical programs of the different church societies, and are always eager to give loyal support to the general church activities.

The Ohio State University is much honored in the election of Dr. Evans as president of the American Chemical Society and feels also that the Society is maintaining its high standard by electing one of Dr. Evans' wide range of experience, genial personality, and effective leadership to this high office.

ACTIVITIES OF THE SOCIETY

JOINT AUTUMN MEETING, MATERIALS & EQUIPMENT AND WHITE WARES DIVISIONS

Summit Hotel, Uniontown, Pa.

September 19 and 20, 1941

A general round-table discussion on Presentation in Plant Terminology of Base Exchange will be conducted at the Joint Autumn Meeting of the Materials & Equipment and White Wares Divisions to be held at the Summit Hotel, Uniontown, Pa., on September 19 and 20. Leaders thoroughly familiar with the subjects will lead discussions on (1) what is base exchange? (2) terms, (3) review and utilization of existing information, (4) fundamental concept, (5) expression of data in plant terminology, (6) adaptation to alter clay properties, (7) adaptation and application to the ceramic process, (8) limitations in clay minerals.

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LETTER FROM WASHINGTON

The following letter was received by E. H. Fritz, president of the Institute, in answer to one written by him to the Committee on Higher Education in National Defense concerning the occupational deferment of ceramic engineers (see the July, 1941, *Bulletin*, p. 257).

Selective Service System,
Washington, D. C.,
July 9, 1941

Dear Mr. Fritz:

Your letter of May 26 to Francis J. Brown, Consultant, American Council on Education, concerning the inclusion of ceramic engineers with the other engineering professions as having a shortage of qualified personnel, has been referred to this headquarters.

As you undoubtedly understand, it is much more difficult to obtain accurate information regarding the supply of qualified professional men in the various professions than those in the skills and semiskills. As a result of this, the Bureau of Labor Statistics selected broad classes of the engineering professions for investigation as to the supply of men in these professions. It is believed that the Headquarters Memorandum dated February 21, 1941, and Headquarters Memoranda I-10, I-62, and I-116 clearly indicate that local boards have ample authority to defer

such ceramic engineers as are found by the local boards to be necessary men within the meaning of paragraphs 350 to 353, inclusive, Volume Three, Selective Service Regulations.

I hope this satisfactorily answers your question. If there is further information needed on this subject, however, please feel free to call upon me.

For the Deputy Director:
JOSEPH F. BATTLEY, *Lt. Colonel, C.W.S.*

CLAY PRODUCTS RESEARCH PROGRAM

In view of the present need for improved designs and construction methods and for additional technical information on conventional types of construction, a comprehensive program of research has been approved by the Executive Committee of the Structural Clay Products Institute, Washington, D. C.

Outline of Program

1. Bomb-Resistant Designs, Cost Studies, and Field Surveys

At the present time, several agencies are studying the effects of bombs on various types of structures. The Engineers Corps of the Army and the Bureau of Yards and Docks of the Navy are conducting bomb tests on structures. The National Research Council and the American Society of Civil Engineers have committees on air-raid protection. In this phase of the research program, a representative of the clay products industry, attached to the engineering staff of the Structural Clay Products Institute in Washington, would cooperate with these agencies in the development of reinforced clay masonry design and in the testing of reinforced clay masonry structures. He would work as an intermediary with these departments and the various agencies engaged in research on structural clay products and would make available to the departments interested all fundamental research data that might be of value in solving problems encountered in the design of bomb-resistant structures. He would compile cost studies, report field surveys, and, with the assistance of the engineering department of the Structural Clay Products Institute, would also assume the responsibility for correlating the work of the various research associates and of reporting their findings together with the results of similar investigations that have been conducted in the past to the Industry Committee on Engineering and Research and the Reinforced Brick and Tile Masonry Research Board. These groups will then be requested to prepare recommendations on good practice in masonry construction, including methods of design and construction details based on the research, for release to the industry.

The estimated cost of this phase of the program, including the labor and material necessary for the construction of test structures and the salary and traveling expenses of one man full time, is $4,600 a year. This portion of the program would take advantage of existing conditions and open up an invaluable market for the further use of clay products. Without facts, this market will pass by the clay products producers for competitive materials.

2. Survey of Industry Products and Tests of Wall and Floor Constructions, Particularly as Adapted to Low-Cost Structures

The Defense Program has greatly expedited the movement toward standardization in this country. The importance of standard designs and standard products has been emphasized many times, and numerous agencies are now engaged in developing national standards and national specifications. In order to attack this problem intelligently for the clay products industry, it is imperative that the representatives of the industry know the types of products that are now being produced and in what volume various units and sizes are available. The industry survey will provide this information. This survey will be conducted by two research associates at the National Bureau of Standards, and at the same time a certification plan will be developed *whereby those who participate in the research program* will obtain a certificate from the Structural Clay Products Institute stating that their products conform to the requirements of the particular grade of the federal and A.S.T.M. specifications applicable as based on tests made at the National Bureau of Standards. Arrangements will then be made with federal agencies to accept a certification from the manufacturer, in lieu of additional tests, that the material furnished conforms to the samples tested by the National Bureau of Standards. This phase of the program will also include an investigation of mortar and efflorescence, the study of the effectiveness and design of construction details such as expansion joints, flashing, coping, parapet walls, and designs for concentrated stress around openings. The estimated cost of this part of the program, including the salaries of two full-time research associates and materials for test specimens, is $3,000 a year. Without the facts that this portion of the program will furnish, clay product material will be greatly handicapped.

3. Development of Reinforced Brick and Tile Masonry

Although some data are already available as to the performance and characteristics of reinforced brick masonry, these data do not cover the entire range of brick produced in the United States and, because the test methods employed by different investigators vary, much of the information cannot be correlated and compared. There is a great need to study the effect of the absorption of the brick when laid upon bond; to compare results obtainable through the so-called grouting method with mortar of mason's consistency; to investigate the effect of plasticizers such as are included in most masonry cements on the bond between the mortar and reinforcing steel; to investigate the effects of various methods of laying or bonding the unit on the strength of masonry and numerous other questions relating to reinforced brick and tile for which there are theories but little actual data.

The Reinforced Brick and Tile Research Board will act as consultants on this part of the research and will plan the program. As data are developed from which conclusions and recommendations may be drawn, the Board will prepare recommendations and authorize their release to the industry. The research work will be done through research fellowships at four state universities so situated *that clay products representative of all types now produced in the United States* can be included in the investigation.

The estimated cost of this part of the program, including the salaries of three research fellows full time and one half time, is $4,200 a year. This information is necessary to the future welfare of the industry.

Concentrated study on the three phases outlined will furnish data that are being demanded by those in authority. If the data are furnished, the industry can prosper. Without it, it will again stand still and watch fact-finding, research-minded competitors building walls, floors, foundations, and roofs. Members of the industry cannot afford to neglect participation in this program.

MONROE J. BAHNSEN PROMOTED

G. H. McIntyre, director of research and laboratories, Ferro Enamel Corp., Cleveland, Ohio, has announced the appointment of Monroe J. Bahnsen as assistant director of the Ferro Laboratories.

Dr. Bahnsen was graduated from the Case School of Applied Science in 1929 and from Western Reserve University in 1934. From 1931 to 1934, he held a Cushman Research Fellowship at Western Reserve. Dr. Bahnsen was employed in the laboratories of the United States Gypsum Company and the Grasselli Chemical Company before he joined the porcelain enamel research staff of the Ferro Enamel Corporation in 1934.

Dr. Bahnsen is a member of the American Chemical Society, The American Ceramic Society, and Sigma Xi. He is co-author with B. J. Sweo of Ferro Technical Bulletin No. 2, "Stabilization of the Reflectance and Color of Recoat Enamels" and of Ferro Technical Bulletin No. 3, "Errors in Reflectance Measurements of Porcelain Enamel Surfaces" with L. S. O'Bannon.

PAUL T. TALBOTT AT BATTELLE

Paul T. Talbott, ceramic engineer, has joined the research staff of Battelle Memorial Institute, Columbus, Ohio, and has been assigned to the division of ceramic research.

Mr. Talbott is a graduate of the University of Illinois and was previously associated with the Cerro de Pasco Copper Corp., Peru, South America, as an experimental engineer. He has been a member of The American Ceramic Society since 1939.

PACIFIC NORTHWEST CLAYWORKERS' ASSOCIATION

The Pacific Northwest Clayworkers' Association held its annual summer meeting on Friday, July 18, 1941, in Spokane, Wash.

During the morning, the group was shown through the Gladding, McBean & Company plant at Mica, Wash., one of the most diversified plants of the Northwest.

After lunch at the Davenport Hotel, the group was entertained by the Washington Brick & Lime Company at its Dishman plant. Of special interest to the group were (1) the glazed building block, which is made in a variety of colors and textures and open fired with Washington coal in round, down-draft kilns, and (2) an experimental gas-producer demonstration using hog fuel, a type of fuel which is abundant in the northwest. Thirty cubic feet of 125 B.t.u. gas may be produced per pound of hog fuel.

The dinner meeting, held in the Early Birds Club in the Davenport Hotel, opened with refreshments provided through the courtesy of Gladding, McBean & Company and the Washington Brick & Lime Company. Neal Fosseen, master of ceremonies, introduced Marion Saindon, Chehalis Brick and Tile Co., president of the Pacific Northwest Clayworkers' Association, and the speaker of the evening, Eric Johnston, vice-president of the United States Chamber of Commerce.

During the business meeting, Wendell Keith, of the Ceramic Engineering Department, University of Washington, was elected secretary to replace Carl H. Zwermann, who was called to active duty in the United States Army.

The Association draws its members from Oregon, Idaho, Washington, and British Columbia, and its meetings are always anticipated with great interest.

UNIVERSITY OF NORTH CAROLINA

Changes in Faculty

W. W. KRIEGEL, who was promoted to associate professor of ceramic engineering in June, was called almost immediately into the Army. He is a captain in the Anti-Aircraft Division of the Coast Artillery and is stationed at Camp Davis, N. C.

R. L. STONE, an instructor last year at the New York State College of Ceramics and previously instructor at the University of North Carolina, has been appointed an associate professor to take Dr. Kriegel's place.

WILLIAM A. SCHOLES, ceramic research engineer in the Department, was appointed a cadet in the Air Corps Engineers and is at present stationed at Chanute Field, Ill.

R. P. MCCABE, teaching fellow in the Department, has been ordered to report, but his station has not been designated. He is a Second Lieutenant in the Infantry Reserve.

J. N. SMITH, JR., who received his M.A. at the University of Alabama in 1941 and his B.Cer.E. at the University of North Carolina in 1940, has been appointed an instructor in the Department.

From all appearances, the Department will have a registration equal to or greater than last year in spite of some losses to the Army and Navy.

—A. F. GREAVES-WALKER,
Professor of Ceramic Engineering

NEW YORK STATE COLLEGE OF CERAMICS

Dean M. E. Holmes has announced the following appointments to the staff of the New York State College of Ceramics.

T. H. DUNKELBERGER has been appointed assistant professor of chemistry. Dr. Dunkelberger was graduated from Dickinson College in 1930 and received the Ph.D. degree at the University of Pittsburgh in 1937. He was assistant professor at the University of Idaho in 1937 and 1938; since then, he has been assistant professor of chemistry at Duquesne University. Dr. Dunkelberger will have charge of the courses in qualitative analysis, quantitative analysis, semimicroqualitative analysis, and spectroscopy.

WILLARD J. SUTTON has been appointed assistant professor of ceramic engineering and research ceramist. Dr. Sutton was graduated from Alfred University in 1917. After two years in military service, he took graduate work at the University of Aix-Marseille, France, the New York State College of Ceramics, and the University of Pittsburgh. He received his Ph.D. degree from the University of Pittsburgh in 1934 and was graduate assistant and instructor there for four years. Dr. Sutton then took charge of the chemistry and ceramic work at Fukien Christian University, Foochow, China, and also served as chairman of the Science College. The war in China, however, made it necessary for Dr. Sutton to discontinue his work there.

VAN DERCK FRÈCHETTE has been appointed graduate instructor in the Department of Ceramic Engineering. Mr. Frèchette was graduated from Alfred University in 1939. Since then he has been doing graduate work at the University of Illinois.

JOHN G. MOHR has been appointed graduate instructor in the Glass Technology Department. Mr. Mohr, who was graduated from the Pennsylvania State College in 1939, has been serving as an assistant at the New York State College of Ceramics.

THOMAS S. HAILE has been appointed graduate instructor in the Department of Industrial Ceramic Design. Mr. Haile was graduated from the Royal College of Art in England in 1931. Since that time he has been art instructor at the Kingston-upon-Thames School of Art, the Hammersmith School of Building and Arts and Crafts, the Leicester College of Art and Technology (all of England), and at the Henry Street Settlement in New York.

EASTERN ENAMELERS' CLUB FALL MEETING

The fall meeting of the Eastern Enamelers' Club will be held at the Park Central Hotel, New York, N. Y., at 3:30 P.M. on Saturday, September 20, 1941.

The meeting will be devoted to the management and operating problems of the porcelain enamel industry under wartime restrictions and the readjustments which follow.

The following program will be presented:

(1) "Will Washington Restrictions Disrupt the Porcelain Enameling Industry?" by CHARLES S. PEARCE, managing director, Porcelain Enamel Institute, Chicago, Ill. The Washington office of the Porcelain Enamel Institute is maintaining constant contact with the government bureaus and offices dealing with defense procurement and regulations. Mr. Pearce will have up-to-the-minute information on the developments in Washington as they affect the enameler.

(2) "Enamel Shop Operation under Present Restrictions on Materials" by HERMAN L. COOK, sales engineer, O. Hommel Co., Pittsburgh, Pa. Mr. Cook, because of his long experience in enameling plant management and his present wide knowledge of operating problems, is prepared to discuss the important subject of shop operations under present restrictions on materials.

(3) "What about Tomorrow?" by R. A. DADISMAN, manager of the Market Development Division, American Rolling Mill Co., Middletown, Ohio. Mr. Dadisman has given much study to the possible requirements of the

future, which must not be overlooked in the rush of immediate problems.

(4) Annual election of officers.

A dinner will be served in the Cocoanut Grove of the hotel at 7:00 P.M. and will be followed by a floor show.

NEW MEMBERS FOR AUGUST

Corporation

AMERICAN CLAY FORMING CO., Ross Stoffer (voter), Tiffin, Ohio.

BAY STATE ABRASIVE PRODUCTS CO., L. M. Krull (voter), Westboro, Mass.

SMITH, A. O., CORP., W. W. Higgins (voter), 3533 North 27th St., Milwaukee, Wis.

Personal

ALLABACH, FRANK, 4116 Howell St., Philadelphia, Pa.; foreman, Gill Glass Co.

BALSER, CLIFFORD S., Homer Laughlin China Co., Newell, W. Va.; tunnel kiln superintendent.

BENNETT, PHILIP M., Y.M.C.A., Evansville, Ind.; superintendent and ceramic engineer, Peerless Sanitary Pottery Co.

BOLLINGER, ROBERT H., 216 Hazelwood Ave., Bound Brook, N. J.; ceramist, Bausch & Lomb Optical Co.

BOZSIN, MICHEAL, Ferro Enamel Corp., 4150 East 56th St., Cleveland, Ohio.

BROOMHALL, VINCENT, Andrews Place, East Liverpool, Ohio; art director, Edwin M. Knowles China Co.

BRYANT, E. E., 75 Cresswell, Bedford, Ohio; research engineer, Ferro Enamel Corp., Cleveland, Ohio.

BUCKLES, PAUL E., 307 S. Wood St., Fostoria, Ohio; ceramic engineer, Auto-Lite Spark Plug Div., Electric Auto-Lite Co.

CATHCART, LYLE, Buck Glass Co., Baltimore, Md.

CHADEVRON, A. A. G., Cleveland Magnesite & Refractory Co., Ltd., Normanby Brickworks, Normanby, Middlesbrough, Yorkshire, England; technologist.

CLARKE, CHARLES W., Box 441, Morton, Ill.; ceramist, Morton Pottery Co.

CRAWFORD, R. G., Homer Laughlin China Co., Newell, W. Va.

DEEDS, C. L., Homer Laughlin China Co., Newell, W. Va.

ECKERT, E. W., 224 West 4th Ave., Derry, Pa.; works engineer, Westinghouse Electric & Mfg. Co.

FISCHER, E. H., Westinghouse Electric & Mfg. Co., Derry, Pa.

GALANIS, TERRY, Joseph T. Ryerson & Son, Inc., 40 Stanley St., Buffalo, N. Y.

GEIGER, JOSEPH S., 904 Arrow Ave., Anderson, Ind.; chief ceramic engineer, National Tile Co.

GOETCHIUS, DON R., Ferro Enamel Corp., 4150 East 56th St., Cleveland, Ohio.

GREEN, LEONARD S., 160 Central Park South, New York, N. Y.; manufacturer of decalcomanias.

GROUT, JOHN R., JR., 400 N. Wood St., Florence, Ala.; assistant chemical engineer, TVA.

GUNZENHAUSER, ADOLF, 339 E. Walnut St., Long Beach, N. Y.; consulting expert for ceramic materials.

HAFNER, HAROLD, 150 Parkdale Terrace, Rochester, N. Y.; research chemist, Bausch & Lomb Optical Co.

HARNISH, J. D., Westinghouse Electric & Mfg. Co., Derry, Pa.

HOWER, ROBERT S., 5219 Gertrude Ave., Pittsburgh, Pa.; Research Dept., Harbison-Walker Refractories Co.

MCGOHAN, G. WILLIAM, American Rolling Mill Co., Middletown, Ohio; products engineer.

PARDEE, RUSSELL, Mexico Refractories Co., Mexico, Mo.

REESE, L. P., Scio-Ohio Pottery Co., Scio, Ohio; president.

RHODES, GROVER C., 49 S. Gaston, Somerville, N. J.; research assistant, Johns-Manville Corp.

ROBERTSON, LEON F., 900 Main St., Brockway, Pa.; company engineer, Brockway Glass Co., Inc.

RYAN, JOSEPH D., 3018 Middlesex Dr., Toledo, Ohio; assistant director of research, Libbey-Owens-Ford Glass Co.

SCHWALM, THEODORE, 304 Atkins Ave., Lancaster, Pa.; foreman, Dial Dept., Hamilton Watch Co.

SESSLER, MATT, 2323 West 3rd St., Cleveland, Ohio; Bassichis Co.

SUTTON, E. L., Maryland Sanitary Mfg. Co., 4500 E. Lombard St., Baltimore, Md.

TUCKER, HARVEY C., Allied Engineering Co., 4150 East 56th St., Cleveland, Ohio; ceramic engineer in charge of glass laboratory.

ULRICH, ROBERT J., 1013 East St. Catherine St., Louisville, Ky.; technical assistant, Research Div., American Radiator & Standard Sanitary Corp.

WEAVER, MEARL V., Limoges China Co., Sebring, Ohio; assistant ceramic engineer.

Student

New York State College of Ceramics: FORREST E. BURNHAM.

Rutgers University: GILBERT GOODMAN.

MEMBERSHIP WORKERS' RECORD

Corporation

A. I. Andrews	1	J. T. Littleton	1
		E. W. Emrich	1

Personal

R. E. Birch	1	O. O. Kenworthy	3
A. V. Bleininger	3	G. R. Pole	1
R. C. Boyd	1	M. R. Scott	1
H. T. Coss	1	D. E. Sharp	1
J. E. Eagle	1	R. A. Snyder	3
E. W. Emrich	2	F. G. Sutphen	1
J. W. Hepplewhite	1	F. E. Tate	1
F. B. Hess	1	Hans Thurnauer	1
M. E. Holmes	2	Robert Twells	1
F. L. Jones	1	F. J. Zvanut	4
	Office	5	

Student

G. H. Brown	1	Office	1
		Grand Total	**41**

ROSTER CHANGES DURING AUGUST*

BROWN, WILLIAM A., Steele's House, Newcraighall Rd., Portobello, Edinburgh, Scotland (formerly in name of Henry S. Brown)

BURCHFIEL, B. M., 1153 Ruberta Ave., Glendale, Calif. (Los Angeles, Calif.)

BURT, ROLAND C., 320 S. Seventh St., Darby, Pa. (Pittsburgh, Pa.)

DOUGAN, CHARLES W., Research Dept., Gladding, McBean & Co., 2901 Los Feliz Blvd., Los Angeles, Calif. (Butte, Mont.)

EYERLY, GEORGE B., Refractories Corp., 3363 Fruitland Rd., Los Angeles, Calif. (Canton, Ill.)

FRANKEL, H. D., Laclede-Christy Clay Products Co., 120 East 41st St., New York, N. Y. (Indianapolis, Ind.)

GEZELIUS, CARL V., U. S. Bureau of Reclamation, Friant, Calif. (Coulee Dam, Wash.)

HALL, MORRIS P., R.F.D. 1, Library Heights, Library, Pa. (Pittsburgh, Pa.)

HELZ, ARMIN W., 1602 Carey Lane, Silver Spring, Md. (Milltown, N. J.)

HENDERSON, CHESTER E., 523 Fourth St., Oakmont, Pa. (Rolla, Mo.)

HOWER, LAWRENCE D., JR., Carnegie-Illinois Steel Corp., 7808 South Shore Dr., Chicago, Ill. (Columbus, Ohio)

LUTHER, HARRY E., Box 1091, Concord, Calif. (Seattle, Wash.)

MOSS, VERNON W., 309 South I St., Lompoc, Calif. (Opportunity, Wash.)

MULLER, MAX M., Lake Shore Hotel, Cleveland, Ohio (Lapeer, Mich.)

* Address in parentheses is former address.

PACKMAN, WILLARD D., New Florence, Pa. (Bolivar, Pa.)
PESKIN, WILLIAM L., 154 Princeton Rd., Elizabeth, N. J. (New Brunswick, N. J.)
PRESSWOOD, COLIN, Oaklands, Aberaman, Aberdare, Glamorganshire, Wales (Yorks, England)
REARDON, LESLIE J., Caribbean Architect-Engineer, Port-of-Spain, Trinidad, British West Indies (Jackson Heights, L. I., N. Y.)
REINKER, GERALD E., Glass Technology Laboratory, 1133 East 152nd St., Cleveland, Ohio (Bridgeville, Pa.)
SCHOLES, WILLIAM A., Company C, Aviation Cadet Det., Chanute Field, Ill. (Raleigh, N. C.)
SMITH, JAMES N., JR., Dept. of Ceramic Engineering, North Carolina State College, Raleigh, N. C. (Tuscaloosa, Ala.)
SMITH, PAUL L., Naval Research Laboratory, Washington, D. C. (Bethesda, Md.)
SNYDER, ERNEST B., 209 N. Fourth St., Allentown, Pa. (Columbus, Ohio)
STUCKEY, ROBERT C., JR., Carnegie-Illinois Steel Corp., 7808 South Shore Dr., Chicago, Ill. (Charlotte, N. C.)
THOMAS, EVERETT A., 1655 South Ave., Niagara Falls, N. Y. (Almond, N. Y.)
WHITWOOD, ROBERT A., 2197 Seneca St., Buffalo, N. Y. (Alfred, N. Y.)

NEW YORK SOCIETY OF CERAMIC ARTS

The Forty-First Annual Exhibition of the New York Society of Ceramic Arts will be held from October 27 through November 20 at the Barbizon Plaza Art Galleries in the Barbizon Plaza Hotel, New York, N. Y.

The Galleries assure the best possible showing of the work to be selected for exhibition, and the hotel itself will afford the utmost in comfortable and congenial surroundings.

The hotel is located in the center of Manhattan and its consequent easy accessibility is expected to aid materially in bringing out the largest number of exhibition visitors and buyers in the organization's history.

All sales will be handled by a member of the Barbizon Plaza staff, Miss Hilda Davis, who will be on duty daily from 10:00 A.M. to 6:00 P.M.

This year's event will be held earlier than in previous years. The work of exhibitors will thus be brought to the attention of prospective purchasers in advance of the Christmas buying season, the best time of the year for sales.

—MRS. WILLIAM P. WILLETTS,
Corresponding Secretary

CERAMICENTER

Of interest to ceramists is the establishment of a Ceramicenter in the Sohmer Building, 31 West 57th St., New York, N. Y.

The Center, under the direction of Syd Lee Gordon, is being established (1) to provide an outlet for retail and wholesale sales of the works of ceramic artists; (2) to bring together artists and buyers for gift shops and department stores, thus creating a larger and more profitable and dependable market for the artist; (3) to establish contacts between artists and manufacturing organizations which can produce in volume from the original designs of creative artists; and (4) to operate a service bureau and management service to perform any functions valuable in advancing the personal and professional interests of the artists represented by the Ceramicenter.

Participation in the benefits of the Ceramicenter involves no fees, membership payments, dues, or advance payments of any sort.

TECHNOLOGISTS AID DEFENSE PROGRAM

The outstanding specialists in the field of nonmetallic minerals in the United States have been formed into an advisory group to deliberate technological problems vital to the nation's defense. The group is a subcommittee of the Advisory Committee on Metals and Minerals which was appointed by the National Academy of Sciences and of which Clyde E. Williams, director of the Battelle Memorial Institute, Columbus, Ohio, is chairman.

The nonmetallic minerals group, which is currently preparing reports on graphite, mica, asbestos, and other strategic minerals, is made up of the following persons: R. P. Heuer, *Chairman*, General Refractories Co., 1600 Real Estate Trust Bldg., Philadelphia, Pa.; Paul Tyler, *Secretary*, U. S. Bureau of Mines, Washington, D. C.; L. E. Barringer, General Electric Co., Schenectady, N. Y.; B. C. Burgess, United Feldspar & Minerals Corp., Spruce Pine, N. C.; W. S. Landis, American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y.; G. R. Mansfield, U. S. Geological Survey, Washington, D. C.; Robert B. Sosman, U. S. Steel Corp., Kearny, N. J.; John D. Sullivan, Battelle Memorial Institute, Columbus, Ohio; Frank J. Tone, Carborundum Co., Niagara Falls, N. Y.; William M. Weigel, Missouri Pacific Railroad Co., Missouri Pacific Bldg., St. Louis, Mo.; M. M. Leighton, State Geological Survey Div., University of Illinois Campus, Urbana, Ill.; G. A. Bole, Edward Orton, Jr., Ceramic Foundation, 1445 Summit St., Columbus, Ohio; R. B. Wittenberg, International Agriculture Corp., 61 Broadway, New York, N. Y.; and Oliver C. Ralston, U. S. Bureau of Mines, College Park, Md.

Other subgroups of the Advisory Committee are working on ferrous minerals and ferroalloys, metals conservation and substitution, and tin smelting and reclamation.

INDUSTRIAL SAFETY REPORT

The need for more effective accident controls to conserve men, money, and materials becomes of paramount importance in times like these when industry is confronted with emergency production demands. Plant expansion, development of new processes, maintenance of heavily worked equipment, employment of new workers, and other similar problems call for more ingenuity and skill on the part of management if a job is to be done well and safely.

Such vital considerations are emphasized in a new report issued by the Industrial Safety Section of the Metropolitan Life Insurance Company entitled "Conserving Men, Money, and Materials in Essential Industries." The report is basically a discussion check list for the industrial executive engaged in emergency production.

Particular stress is laid on the proper consideration of accident costs. The enormous potential losses of precious time and the spoilage of equally precious materials that result from mishaps, sometimes termed "near accidents," are of far greater significance than the threat of personal-injury accidents and are generally overlooked in compiling accident reports or statistics. These indirect losses, however, represent very real items of industrial waste to the production executive.

The report also briefly develops several fundamental considerations for employee safety to aid in the study of industrial accidents and to point out proper means for their control.

Copies of this report may be obtained by executives writing on their business stationery to the Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York, N. Y.

DIRECTORY OF INDUSTRIAL RESEARCH LABORATORIES

Copies of this valuable publication may be obtained from the National Research Council, 2101 Constitution Ave., Washington, D. C., at $3.50 each.

ART DIVISION AUTUMN MEETING, BLUE RIDGE, N. C.

August second and third were the two closing days of the Southern Art Institute Conference at Blue Ridge. They were devoted to ceramics under the direction of Kenneth E. Smith, chairman of the Art Division of The American Ceramic Society. Professor Smith is also Head of the Ceramic Art Department, Sophie Newcomb Memorial College, New Orleans, La. At Blue Ridge, Professor Smith directed and instructed a six-weeks' course in ceramic art.

The accompanying photographs show the ceramic art exhibits. The illustrated addresses by Miss C. Genevieve Lawler, Jack Smoot, Eugene Deutsch, and H. Carey Hansard were delivered to groups of from fifty to seventy-five persons. Discussions were lively and informative. W. E. Stephens of the Pisgah Forest Pottery and Ernest A. Hilton translated the art and technical fundamentals in terms of North Carolina highland pottery making.

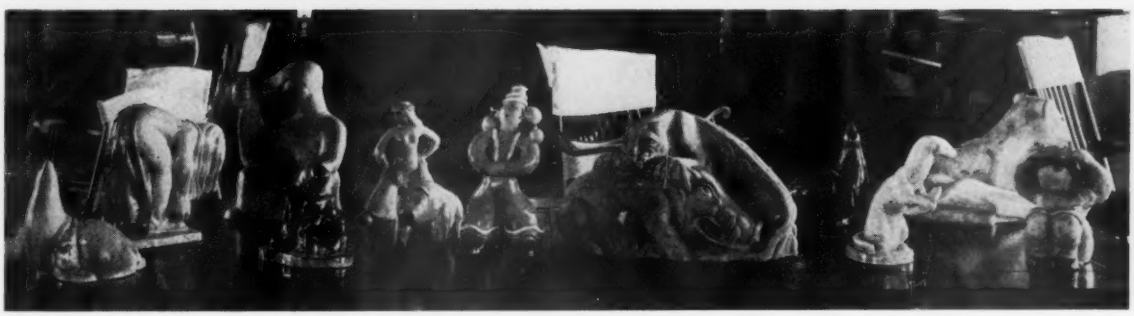
The free-hand cameo decorations by Mr. Stephens on his cone 10 porcelain artware and the underglaze slip painting by Mrs. E. A. Hilton on Hilton "Jugtown fancy wares" were admired and discussed. This autumn meeting of the Art Division gained added interest and value by visits to the Hilton and Pisgah Forest potteries and other potteries near by.

From Georgia came Jack Smoot and H. Carey Hansard with examples of artware development in that state. Where these two men are there is sure to be a growing interest in both ceramic art and ceramic technology.

Richness was added to this autumn program by visits to the Associate Arts Studios directed by Miss C. Genevieve Lawler, ably assisted by Mary Ruth Lionberger. Their studio-camp is situated seven and one-fourth miles east on Highway 70 from Asheville and about the same distance west on the same highway from Blue Ridge.

The camp plant consists of the large main house with office and dance and singing hall on the lower floor. Here is the stone fireplace which takes six-foot logs, and here is the exhibit of the Gertrude Roberts Smith textiles. On the mezzanine floor, which breaks the fifty-foot height to the

Ware made by southern potters.



Ceramic sculpture by Eugene Deutsch.

vaulted ceiling, are the Design and the Graphic Arts studios, the tea-party alcove, and the informal library. The library consists of a carefully selected collection of art publications, the books covering each of the associate arts, poetry, fiction, and nonfiction of general interest. Other studios are the Gertrude Roberts Smith Weave House, the Workbench, the Craft Pavilion, the Kiln Sheds, the Jewelry Shop, and the Outdoor Arts Fair and Workroom. The Village consists of twelve cabins, a central bath house, and the Casserole Kitchen.

W. D. Weatherford, president of Blue Ridge College, Inc., and R. M. Grumman of the University of North Carolina, Chapel Hill, N. C., deserve credit for this Blue Ridge Southern Culture Institute. It is substantially and adequately operated. It deserves a liberal support not only by people from the states south but by people nationally.

Sculpture of southern potters.

NECROLOGY

HENRY S. BROWN

Word has been received of the death of Henry S. Brown, 7 Corsebar Drive, Meikleriggs, Paisley, Scotland. His death, as stated in the communication received, was caused "by enemy action."

Mr. Brown was associated for many years with Robert Brown & Sons, Ltd., Paisley, one of the oldest sanitary earthenware companies in Scotland, and for a number of years he had been chairman of the British Sanitary Fireclay Association.

Mr. Brown had been a member of The American Ceramic Society since 1928.

WALTER R. LEACH

Walter R. Leach, secretary and general manager of the Carr-Lowrey Glass Company and a national figure in the glass industry, died Sunday, August 3, 1941, at his home, Chela Farms, Phoenix, Baltimore County, Md., after a short illness.

Mr. Leach was born in Baltimore, December 8, 1880, and, following a public-school elementary education, he entered the employ of the Carr-Lowrey Glass Company as an office boy at the age of fifteen. When he was eighteen, he was sent out on the road as salesman. He became general manager of the Company in 1914 and secretary in 1917.

Mr. Leach was a member of the Standardization and Tariff committees of the Glass Container Association.

He is survived by his widow, Elsie Wagner Leach, two sons, Walter R. Leach, Jr., and C. Edward Leach, and by a brother, E. Edwin Leach.

Walter R. Leach

JUNIUS FREDERICK KREHBIEL

A member of The American Ceramic Society since 1906, one of the one hundred who organized the honorary Fellow group, an active member and officer in the Ceramic Camera Club, a charter member of the Institute of Ceramic Engineers, Junius Frederick Krehbiel passed away on July 29, 1941. He had been in ill health for three years and had been confined to his bed for the last five months.

Mr. Krehbiel, aged sixty-one years, seven months at the time of his death, was born in Yorkshire Center (now Delevan), N. Y., December 29, 1879, the son of Dr. Frederick and Emma Beach Krehbiel.

In 1896, he was graduated from Delevan High School. In 1900, he entered and in 1904 he was the first to be graduated from the New York State School of Clay Working and Ceramics with a degree of B.Sc. in ceramics.

From June, 1904, to June, 1906, he was with the Robineau Art Pottery, Syracuse, N. Y. In June, 1906, he joined the staff of the University of Illinois Department of Ceramic Technology.

Junius Frederick Krehbiel

For five years, he was employed by W. D. Gates of the American Terra Cotta Company to design a line of artware, especially in mat and crystalline glazes, and in 1911, he joined the research staff of the Ohio Geological Survey.

From 1912 to 1914, he was employed at the Standard Pyrometric Cone Company in Columbus, Ohio. From 1914 to 1918, he was with the Advance Terra Cotta Company, Chicago, Ill., returning to the Standard Pyrometric Cone Company in 1918 and continuing there until 1929.

In 1929, Mr. Krehbiel established the Accurate Pyrometric Cone Company in Pataskala, Ohio, and here, under the direction of his sons, Helmer and Frederick Krehbiel, the Company is being continued.

Mr. Krehbiel was a member of the Pataskala Methodist Church, in which he was World Service Treasurer and a member of the Board of Trustees. He was also a member of the Village Council, the local Library Board, the local Masonic Lodge, the Scottish Rite, and the Shrine and he was the founder of the last Boy Scout troop in Pataskala. He was past-president and organizer of the Ohio Milk Goat Breeders Association. Since 1931, his name has been listed in Who's Who in Engineering.

Mr. Krehbiel is survived by his sons, Frederick H. and Helmer O., and a sister, Nellie M. Krehbiel.

A friend since college days recently wrote to Mr. Krehbiel as follows: "I think you know that I have been a consistent admirer and respecter of your fine intellect for all of the years we have known each other, and in addition I have always respected you for your ability to apply your intellectual findings. I have always envied you for your analytical mind which is coupled with tireless faithfulness to detail and a liking for accuracy to the nth degree."

Mr. Krehbiel will be greatly missed in the church and in the community, as well as in ceramic circles.

WILLIAM BURTON A GREAT POTTER

The death of William Burton, one of the great potters of England, is mourned in England and in the United States alike. The high esteem in which Mr. Burton was held is shown by the following notices from the *Manchester Guardian* of April 7 and 8, 1941.

Distinguished Career

We regret to record the death of William Burton, the well-known potter, which has occurred in London. He was in his seventy-eighth year.

William Burton probably influenced the industry and art of pottery making more than any other Englishman of his time. He was a pottery expert in so many directions—a trained chemist in the first place; then a manager and organiser of business; and finally, a student with immense knowledge of the history of his craft and the gift of awakening the interest of other people. Brought up in Lancashire and trained as a chemist, it was probably an advantage to him that he entered the pottery industry in this way from outside. The Staffordshire manufacturers in the nineteenth century had stereotyped the methods by which Wedgwood and his contemporaries in the previous century made the pottery trade of Britain the first in the world. Although there was a fine tradition of ordinary workmanship, scientific direction was almost unknown, and an important part of Mr. Burton's work was the help he gave to the task of joining science to the potter's craft.

Born in Manchester in 1863, he attended first an elementary school and later the evening classes at Owens College. From Owens, he went up to the Royal College of Science as the premier National Scholar of his year. Leaving the college in 1887, he was for a few years a chemist at the famous works of Josiah Wedgwood and Sons at Etruria, Staffordshire, coming afterward to the Pilkington Tile and Pottery Company's works at Clifton Junction, of which he became general manager. Here, with the good will and support of the Messrs. Pilkington in many experiments, he had full scope for his gifts; and out of what was at first a relation to pottery on its scientific side there developed a distinguished contribution to its art.

William Burton and his brother, Joseph Burton, who in time took over most of this work of research at the Clifton pottery, not only found out many old and important secrets but introduced one series after another of new and strikingly beautiful lustres and crystalline and other glazes. The ware they produced, which have become world famous as "Lancastrian" pottery, were unrivaled in richness and variety of colour and texture and showed a wealth of effect in their kind such as had never before come from the hands of the potter. Following and extending the honourable tradition in the craft, full credit was given to the craftsmen who designed and painted the pieces produced. In the early days, such well-known men as Walter Crane and Lewis F. Day furnished many designs for tile and vases, but later on this work was done by the artists employed wholly by the firm.

Mr. Burton retired from the office of manager and director in 1915. Along with much public work, he found time to make a distinguished position for himself as a writer on the history and manufacture of pottery. His books on English Porcelain (1902), English Earthenware and Stoneware (1904), and Porcelain (1906) were at once

recognized as authoritative. He was also a valued contributor to the *Manchester Guardian*.

As a member of a committee appointed by the Board of Education, Mr. Burton shared in the rearrangement of the South Kensington Museum and in the revision of the relationships between the board and the local schools of art. In Manchester, he took part in the management of educational, artistic, and scientific institutions—the School of Art, the Northern Art Workers' Guild, the Literary and Philosophical Society, and others. Manchester University showed its appreciation of his work by conferring on him in 1908 the honorary degree of Master of Arts.

Delightful Personality

William Burton was a man of agile mind and tireless energy; he had a great flow of conscious strength and competence, so that the impression he made was that whatever work was entrusted to him would be done with thoroughness and finish. He was a great teacher, not only by word of mouth, a method in which he excelled, but in action, for he never lost the eagerness of his youth in the pursuit of experiments to bring him a greater mastery of the processes of his business; he was up early and late to follow the workings of the kiln on any of his new projects.

He was naturally of quick intelligence and impatient to come to great conclusions, but chemistry, and particularly the difficult section of it that has to do with clay, had been a stern school to him, and the many failures before success arrived had tempered him to a fine quality of sympathy for those similarly willing to go to school. But how he could pour out his scorn on those holiday minds that pick up odd scraps of knowledge as they pass the door and promptly suppose themselves to know! It was fun to watch a duel in argument between him and any unwary one who had the temerity to cross swords with him, for great were the blows he dealt, but the very vigour of the debate often indicated that his opponent had made an impression on him, which he would afterward generously acknowledge, for though he liked to obtain the victory, it was always the truth he sought.

His sense of humour was keen and truly English. It was not cerebral, like the Irish or American, but rather a moral quality, an abounding good humour, willing always to see the pleasant and ridiculous side of life rather than to dwell on the irony of things. He was a delightful companion and charming host. His generosity knew no bounds; it ran almost to a fault, and though he was not always conscious of it he liked to do things "en prince." His kindness showed itself in everything about him and was the cumulative effect of his personality.

RESEARCH, A NATIONAL RESOURCE II, INDUSTRIAL RESEARCH*

A report on the research resources of the United States has been prepared for the National Resources Planning Board by a special committee of the National Research Council. The findings and recommendations of the Committee have been summarized in the report as follows.

Findings

(1) Continuous and increasing application of science by industry is contributing most significantly to the high standard of American living. Viewed in this light, industrial research is a major national resource.

(2) The United States has become the acknowledged leader in industrial research.

(3) American industry employs over 70,000 research workers in over 2,200 laboratories at an estimated annual cost, based on an average of figures reported, of the order of $300,000,000.

(4) Industrial research is generally accepted both by informed labor and by informed management as a desirable and constructive force. Organized labor is officially on record in favor of research, and the annual reports of many of the most successful corporations have stressed the relation of research to earning power.

(5) Small and moderate-sized companies were found whose principal means of competitive defense against larger companies is industrial research. One company mentioned specifically that, as a defense against competition from a merger of other companies in the industry, a policy of research was adopted and special products were developed, and in consequence there has been continuing heavy demand.

(6) One hundred and eighty-one manufacturers report expenditures for industrial research of 2% of gross income as a median, the percentage varying with company size and from one industry to another.

(7) Industrial research is possible for all industrial units, small and large. The distribution of research in industry seems to follow no definite rule but to depend rather on management policy. It is apparent that research is most active in companies utilizing technically trained men in design, production, or sales activity.

(8) Industrial research acts as a protection against unfavorable changes taking place both within and without an industry.

(9) A great difference exists in the direct utilization of research by different industries. A few industries still depend almost altogether on sources of supply for their technical advance whereas others have themselves made great strides in the application of science.

(10) Industry looks to the universities for trained technical men and for principal advances on the frontiers of science. It is of interest, however, that advances are not infrequently made on these frontiers in the course of research projects originally designed to achieve immediate commercial objectives.

(11) The United States is now virtually independent of foreign sources for adequate apparatus and facilities for laboratory research.

(12) Cooperation and coordination in industrial research take various forms. Some industries cooperate through associations, especially in studying problems common to an industry. Frequent instances of cooperation between noncompeting companies are noted. It is the belief of those responsible for this report that the danger of unnecessary duplication of research by competitive industry will remain slight. No special steps are recommended at this time to improve coordination and to prevent duplication.

(13) Relations between research men in government and in industry are, in general, close and cordial. Industry generally is continuously cooperating reciprocally with the Army and Navy and with the technical branches of other departments and bureaus in the government. A factor reported as interfering to some degree with even more effective use of industrial cooperation by War and Navy departments is the extension of secrecy to the point of not informing industry freely of troublesome problems. It is possible that less restriction might be placed on information about the existence and nature of problems while at the same time taking care that the solutions, when found, are treated with discretion.

(14) Some branches of applied science are more highly developed in industry than others. Chemistry, notably, has been widely accepted and applied, and more than a quarter of the members of industrial research staffs are chemists or chemical engineers. Biology, however, has not obtained the same general acceptance, even in the food industries where there is great opportunity for wider utilization of applied biology. It is believed that the biologists themselves could take steps toward correcting this situation, as did the physicists in the formation and operation of the American Institute of Physics.

(15) There is opportunity for some American university to establish a comprehensive curriculum in applied mathematics. The number of men engaged in applied

* This report, issued by the National Resources Planning Board in December, 1940, may be obtained from the Superintendent of Documents, Washington, D. C. It contains 370 pages and costs $1.00.

mathematics is comparatively small, but their work is extremely significant. It could be made even more significant through special educational facilities.

(16) Industrial research men are members of a profession with high ethical standards. Compensation for industrial scientists is in general comparable with that for men with equivalent responsibility elsewhere in industry.

(17) Industrial research has an ever-widening field and shows no tendency to terminate or even to be restricted for lack of new opportunity.

Recommendations

To Industry

(1) Several large industries are found to lack extensive provision for research. It is recommended that leaders in such industries associate themselves with representatives of the National Research Council in a systematically organized investigation of the possibilities of their undertaking industrial research and of practical ways and means for realizing the possibilities.

(2) Although no attempt is made in this report to define a procedure for initiating research, the various studies and the introduction suggest several sources of information and cooperation in providing for research. It is recommended to companies not now conducting research that they consult one or several of the sources of cooperation indicated in this report and consider carefully the establishment of research as a continuing activity. The section on small industries and the introduction, in particular, may be found helpful for this purpose.

(3) In order that more extensive and effective application of the biological sciences in the food industry may be encouraged, it is recommended to companies in the prepared and preserved food fields that common ground be sought for the joint support of fundamental biological research.

(4) Some companies publish scientific findings regularly, and in general publication is permitted when protection of the new findings has been assured. In the opinion and experience of the Committee, industries have not suffered but have profited by adopting a liberal publication policy.

To Labor and Industry

(5) An almost untouched and extremely profitable field for cooperation is believed to exist in the conduct of research on fatigue and related matters affecting the welfare of labor and thus, also, industry. It is recommended that labor and industry join in initiating systematic research in this field.

To Government

(6) Industrial research as a national resource capable of contributing to public welfare should be fostered. Any restrictive policies on research on the part of the government are opposed to the public interest. For example, any tendency toward insisting upon capitalization of research expenditures for tax purposes might prove a dangerous threat to the welfare of industrial research.

(7) In several branches of pure and applied science, abstracts of the technical literature are supported by scientific societies. Such support is becoming increasingly burdensome and increasingly inadequate in the face of the enormous and rapidly expanding amount of technical matter being published. An excellent means of government contribution to industry would be proper provision for systematic and complete publication of abstracts of scientific and technical literature.

(8) Provision should be made for the extension and revision of the International Critical Tables of Numerical Data, Physics, Chemistry, and Technology, originally published in 1926 under the auspices of the International Research Council and the National Academy of Sciences. These critical tables are the principal combined source of authentic records of properties of materials. As such they should be brought and kept up to date.

(9) Extension of research means increasing dependence upon adequate and correct standards of reference. Establishment of standards requires most exacting and long-continued laboratory work, a high caliber of technical personnel, and frequently expensive facilities. There is need for much more research on standards of measurement than is now conducted, and it is recommended that the National Bureau of Standards be given encouragement and increased tangible support for research on standards. It is also recommended that any appropriations for such support provide ample funds for adequate publication and distribution of the Bureau's findings.

(10) In order that findings of government laboratories generally be made readily and continuously available to industry, it is recommended that government bureaus receiving appropriations for scientific work be less restricted than at present in allowances for representation at technical meetings, for publication of findings, and in general for cooperation with industrial technical workers.

Outline of Contents of Report

Summary of Findings and Recommendations

I. Report on Industrial Research as a National Resource, Introduction

II. Research in the National Economy
- (1) Development of Industrial Research in the United States
- (2) Research, a Resource to Small Companies
- (3) Coordination Between Industries in Industrial Research
- (4) Technical Research by Trade Associations
- (5) Fundamental Research in Industry
- (6) Careers in Research
- (7) Research as a Growth Factor in Industry
- (8) Industrial Research Expenditures

III. Examples of Research in Industry
- (1) Research in Aeronautics
- (2) Research in the Petroleum Industry
- (3) Research in the Iron and Steel Industry

IV. Location and Extent of Industrial Research Activity in the United States

V. Research Abroad

VI. Men in Research
- (1) Chemistry in Industrial Research
- (2) Physical Research in Industry as a National Resource
- (3) The Role of the Biologist in Industry
- (4) Industrial Mathematics
- (5) Metallurgical Research as a National Resource
- (6) The Chemical Engineer in Industrial Research
- (7) Industrial Research in the Field of Electrical Engineering
- (8) Industrial Research by Mechanical Engineers
- (9) The Significance of Industrial Research in Borderline Fields

VII. Appendix
- (1) Relationship of the National Research Council to Industrial Research
- (2) Acknowledgments

REFRACTORIES DIVISION AUTUMN MEETING

Session Subject: Methods of Bricklaying as Applied to Refractories

The technical session of the Refractories Division Autumn Meeting was held in Life Science Hall, Denison University, Granville, Ohio, on Friday, September 5, at 1:30 P.M.

The following papers were presented:

(1) "Design, Construction, and Operation of Open-Hearth Furnaces with Basic Roofs" by LEWIS B. LINDEMUTH, consulting engineer, New York, N. Y.

(2) "Bricklaying and Steel Plant Refractories" by ALEX MORTON, superintendent of construction, Pittsburgh Steel Co., Monessen, Pa.

An open discussion followed each paper.

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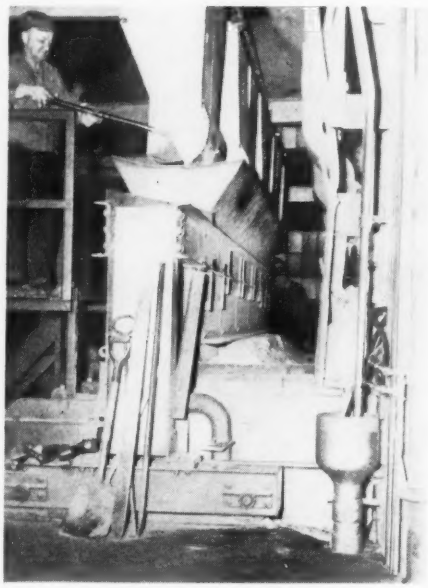

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Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay (Process Equipment)
Lancaster Iron Works, Inc.
National Engineering Co.

Clay (Sagger)
Great Lakes Foundry Sand Co.
The Hommel, O., Co., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay-Slip (Albany)
Hammill & Gillespie, Inc.
United Clay Mines Corp.

Clay (Wad)
Kentucky Clay Mining Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

Clay (Wall Tile)
Hammill & Gillespie, Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
Thomas Alabama Kaolin Co.
United Clay Mines Corp.

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Pennsylvania Salt Mfg. Co.
Porcelain Enamel and Mfg. Co.

Cleaners, Chemical
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Pennsylvania Salt Mfg. Co.

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Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Cobalt Sulphate
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Harshaw Chemical Co.
The Hommel, O., Co., Inc.

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Drakenfeld, B. F., & Co.
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Harshaw Chemical Co.
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Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
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Cones
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Harshaw Chemical Co.
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The Hommel, O., Co., Inc.
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The Vitro Mfg. Co.

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Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

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Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

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Porcelain Enamel and Mfg. Co.
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The Vitro Mfg. Co.

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Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.
Norton Co.
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Drakenfeld, B. F., & Co.
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Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
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Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.

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The Hommel, O., Co., Inc.

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Electro Refractories & Alloys Corp.
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Denver Fire Clay Co.
Electro Refractories & Alloys Corp.

Slabs (Furnace)
Carborundum Co.
Electro Refractories & Alloys Corp.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.

Soda Ash
American Potash & Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.

Sodium Metasilicate
Harshaw Chemical Co.

Sodium Nitrite
Harshaw Chemical Co.
The Hommel, O., Co., Inc.

Sodium Silica Fluoride
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.

Sodium Uranate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.

Soot Blowers
Frazier-Simplex, Inc.

Special Machines
Frazier-Simplex, Inc.

Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
Pennsylvania Pulverizing Co.
The Vitro Mfg. Co.

Spray Booths
The Hommel, O., Co., Inc.

Spraying Equipment
The Hommel, O., Co., Inc.

Spurs
Louthan Mfg. Co.
Potters Supply Co.

Stacks
Lancaster Iron Works, Inc.

Steel Plate Construction
Lancaster Iron Works, Inc.

Stilts
The Hommel, O., Co., Inc.
Industrial Ceramic Products, Inc.
Louthan Mfg. Co.
Potters Supply Co.

Sulfuric Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Pennsylvania Salt Mfg. Co.

Talc
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Paper Makers Importing Co.

Tanks
Frazier-Simplex, Inc.

Tank Blocks
Corhart Refractories Co.

Tanks (Pickle)
The Hommel, O., Co., Inc.

Tanks for Raw Material Steel or Concrete
Lancaster Iron Works, Inc.

Tile (Floor)
Norton Co.

Tile (Muffle)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Tile Setter Pins
Louthan Mfg. Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Thomas Alabama Kaolin Co.

Tile (Wall)
Denver Fire Clay Co.
Thomas Alabama Kaolin Co.

Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.

Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Trisodium Phosphate
Harshaw Chemical Co.

Trucks
Lancaster Iron Works, Inc.

Tubes (Insulating)
Carborundum Co.
Louthan Mfg. Co.
McDanel Refractory Porcelain Co.
Norton Co.

Tubes (Pyrometer)
Carborundum Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

Uranium Oxide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.

Uranium Oxide (Yellow-Orange-Black)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc , R. & H. Chemicals Dept.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.

Water Softening Plants
Frazier-Simplex, Inc.

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
The Hommel, O., Co., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Whiting
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Winding Drums
Lancaster Iron Works, Inc.

Zinc Oxide
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
The Vitro Mfg. Co.

Zircon
Foote Mineral Co.
The Hommel, O., Co., Inc.

Zirconia
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel, O., Co., Inc.
Metal & Thermit Corp.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Zirconium Oxide
Foote Mineral Co.
The Hommel, O., Co., Inc.
Titanium Alloy Mfg. Co.

Zirkite (Natural ZrO_2)
Foote Mineral Co.

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February 1939

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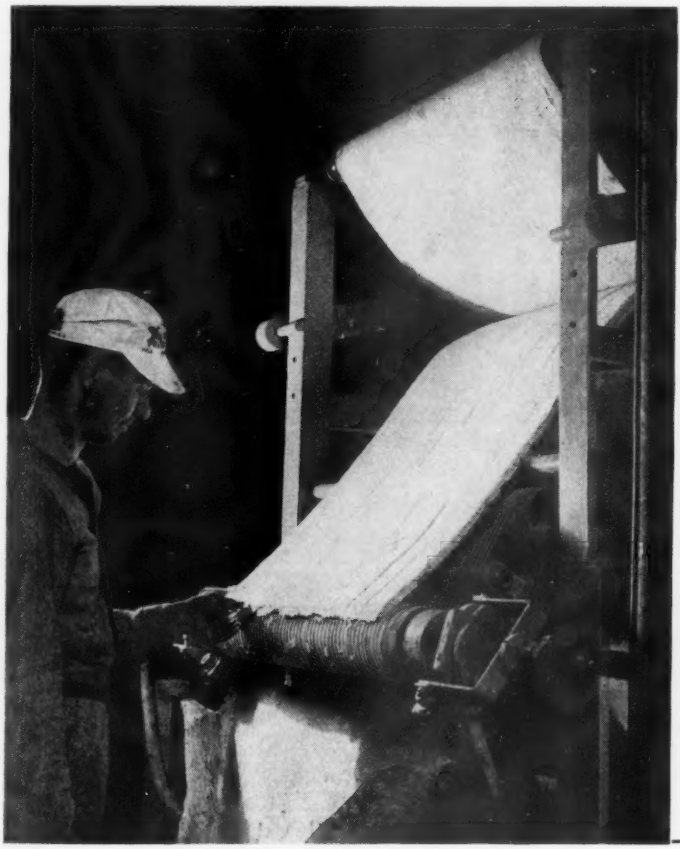
2525 North High Street, Columbus, Ohio



LITHIUM
Carbonate

To put a smoother complexion on your glaze—for a higher gloss and the elimination of pinholes—we suggest Foote's Lithium Carbonate—a small percentage has "lifted the face" of many glazes.

FOOTE
Mineral Company
Phila., Penna.

One type of filter used at the chemical plant for the production of Lithium.

CERAMIC DATE-BOOK ENTRIES

1. Forty-Fourth Annual Meeting
   The American Ceramic Society, Inc.
   Hotel Netherland Plaza
   Cincinnati, Ohio
   April 19–25, 1942

2. Joint Meeting, Materials & Equipment and White Wares Divisions
   Summit Hotel, Uniontown, Pa.
   September 19–20, 1941

3. Porcelain Enamel Institute Forum
   Ohio State University, Columbus, Ohio
   October 8–10, 1941

4. Institute of Ceramic Engineers with Industrial Division, A.I.-M.M.E., Rolla, Missouri
   October 23–25, 1941

5. Tenth Annual Ceramic Exhibition
   Syracuse Museum of Fine Arts
   October 18 to November 12, 1941

6. Structural Clay Products Institute
   Hotel Mayflower, Washington, D. C.
   November 4–6, 1941

7. Glass Problem Conference
   University of Illinois
   November 7–8, 1941

8. 50th Anniversary, University of Chicago
   Frontiers in Geological Science
   September 25–26, 1941

9. Electrochemical Society, Inc.
   Hotel Knickerbocker
   Chicago, Illinois
   October 1–4, 1941

10. Eastern Enamelers' Club
    Park Central Hotel, New York, N. Y.
    September 20, 1941

11. Chicago District Enamelers' Club
    Chicago, Illinois
    September 27, 1941

12. Forty-First Annual Exhibition
    New York Society of Ceramic Arts
    Barbizon Plaza Art Galleries
    Barbizon Plaza Hotel, New York, N. Y.
    October 27 through November 20, 1941

13. Abrasive Wheel and Grain Associations
    Oyster Harbors Club
    Osterville, Mass.
    September 17–19, 1941

I N G-R I C H

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"The Plant Tested Frit"

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FRANKFORT, INDIANA

FOR THE KILN ROOM

LOUTHAN HI-FIRE Refractories

PINS · STILTS · SPURS
DECORATING THIMBLES
FIRING RACKS
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THE LOUTHAN MANUFACTURING CO.
CERAMIC SPECIALISTS SINCE 1901
NEW YORK EAST LIVERPOOL, OHIO LOS ANGELES

99 1/2 % PURE KAOLINITE

"Properly Priced for Very Large Users"

Write for Information and Samples

P. C. E. CONE 35

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2412 Ken Oak Road, Baltimore, Md.

Mines: Chalk Bluff, Ala. Processing Plant: Hackleburg, Ala.

Analysis	Loss on ignition	13.89%
	Silica (SiO_2)	44.74
	Aluminum oxide (Al_2O_3)	39.47
	Titanium oxide (TiO_2)	1.29
	Ferric oxide (Fe_2O_3)	0.55
	Lime (CaO)	0.00
	Magnesia (MgO)	0.00
	Alkalis (Na_2O, K_2O)	0.00
Mechanical Composition	—20 microns	98.00%
	—10 "	80.98
	— 6 "	70.94
	— 3 "	54.70
	— 1 "	37.74
	— 0.5 "	21.75

CLAYS

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Ceramic Specialties Include

Whiting : Paris White : Magnesite
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SUPPLIERS OF ALL CERAMIC NEEDS

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Never too busy to be Good Neighbors

THERE are a lot of workers in the Bell System—about 350,000 of them. That's a big family and it likes to be a friendly kind of family.

Whether it be the installer in the house, the people in our offices, the operators or the lineman on the roadside helping to rescue a stray kitten for a worried youngster, telephone workers are close to the public and the tradition of the job is helpfulness.

Even in these days when the needs of defense place sudden and increasing demands on telephone workers, they are never too busy to be good neighbors.

Bell Telephone System

"The Telephone Hour" is broadcast every Monday. (N.B.C. Red Network, 8 P.M., Eastern Daylight Saving Time.)

H. C. SPINKS CLAY COMPANY

Miners and Shippers of

BALL, SAGGER AND WAD CLAY

NEWPORT, KY.

Sept. 6, 1941

Mr. Pete Potter
Comfortable Sanitary Pottery Mfg. Co.
Pottsville, U. S. A.

Dear Pete:

The summer sure passed in a hurry. The way the Cincinnati Reds have been playing, I am sorta glad football is getting started. Looks like it is getting so about all you can depend on is what has already happened.

Well, SPINKS BALL CLAYS have proven their dependability, and we haven't been loafing this summer. The sheds are nearly full. Going to try to keep them full, but hope you make that awfully hard for us to do.

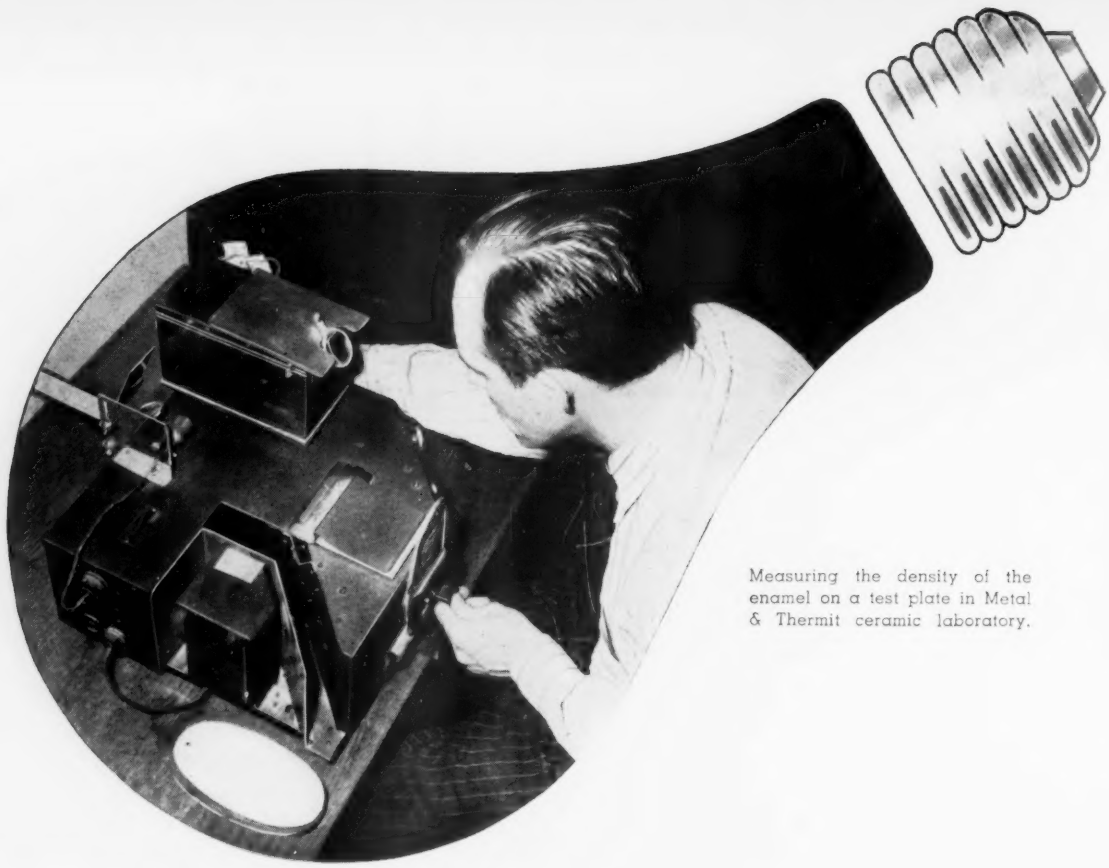
Thanks for making us work overtime.

Sincerely,

Dick Carothers

General Manager
H. C. SPINKS CLAY COMPANY

RBC:MLN



Measuring the density of the enamel on a test plate in Metal & Thermit ceramic laboratory.

throwing light on opacity...

A manufacturer of reflectors had to stop production because he found that the opacity of the glaze was not adequate to meet rigid reflectance specifications.

Metal & Thermit engineers were called in. An improvement in reclaiming spray booth scrapings and a change to M & T Tin Oxide remedied the condition and enabled production to be immediately resumed.

If you have a glaze or enamel production problem consult us about it. The experience of our ceramic laboratory in solving hundreds of problems involving the production of glazes and enamels to meet all sorts of conditions, is at your disposal.

Here are two opacifiers which have been proven again and again by leading ceramic manufacturers as to purity, uniformity and ability to impart a brilliant, even finish. Careful laboratory control in the manufacture of the opacifiers and continual production of test samples of enamels are a constant check on their quality.

M&T

TIN OXIDE

SODIUM ANTIMONATE

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METAL & THERMIT CORPORATION

120 BROADWAY NEW YORK, N. Y.

Vol. 20, No. 9 (September), pp. 295-336 (1941)

THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY